Vol. 47 No. 2 October 1953

Quarterly

of the

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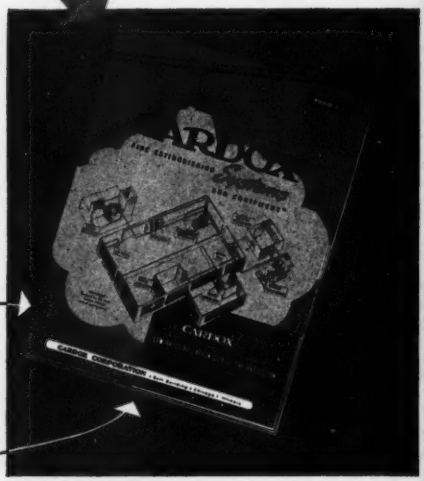

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Quarterly

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The Pueblo Star-Journal

Two other buildings were destroyed, eight were damaged and one man was killed in this $1,000,000 fire at Pueblo, Colorado on August 29, 1953. The fire started in an adjoining 2-story hotel and spread to the "Central Block" through 36 plain glass windows on upper stories. No estimate can be made of the indirect losses to be experienced by the 43 offices, 12 stores, 2 hotels and 1 business college whose quarters were destroyed. (See article, page 139, "Indirect Fire Losses in Business.") Fifteen firemen were injured including one in the photo who was struck by falling masonry.

Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

ROBERT S. MOULTON ..... *Editor*
GEORGE H. TRYON, III ..... *Associate Editor*
CHESTER I. BABCOCK ..... *Fire Record Editor*
MARGUERITE C. CHAFFIN ..... *Editorial Assistant*
HENRY S. GERE ..... *Advertising Manager*

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The National Fire Protection Association is a non-profit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of 15,000. The *Quarterly* is one of the publications regularly provided to members. Other membership publications include a monthly *Fire News, Advance Reports* and *Proceedings* of the Annual Meetings, a *Year Book*, and many leaflets, pamphlets and posters issued throughout the year on fire prevention and control.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association (annual dues $12.50) affords an opportunity to keep abreast of these developments and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

All members of the Association and the public are invited to NFPA meetings. The following dates are now on the Calendar:

NFPA Calendar

1953	
Oct. 29-30	NFPA Regional Meeting, Providence
1954	
Jan. 25-29	NFPA Committee Week, Hotel Martinique, New York
Jan. 28	NFPA Board of Directors, N. Y.
Mar. 15	Closing date for 1954 Committee Reports
May 17-21	NFPA Annual Meeting, Hotel Statler, Washington, D. C.
Sept. 20-22	NFPA Regional Meeting, Seattle
Oct. 3-9	Fire Prevention Week

The closing date for articles submitted for the *Quarterly* is the 15th of the month preceding publication.

Editorial

Sparky a National Character

AT our 1950 annual meeting in Atlantic City, Vice-President Allan Wilson of the Advertising Council made the first formal announcement to the membership of NFPA that the Advertising Council had approved a national campaign for fire prevention with the NFPA as sponsor, the campaign to be launched during the fall of 1951.

Early in the campaign the Advertising Council experts were casting about for an appealing symbol that would catch on with the public, and Ted Royal of the Council staff, who is the account executive for the fire prevention campaign, made the suggestion that the Dalmatian dog, so widely associated in the minds of the public and especially of children as a firehouse mascot, would make the ideal character symbol for this campaign. At a luncheon given by NFPA at the Hotel Pierre in New York on April 3, 1952, *Sparky*, in the person of a pedigreed Dalmatian puppy, made his first public appearance. *Sparky* was entrusted to Stanley Withe of the Aetna Life Affiliated Companies of Hartford, Chairman of the NFPA Committee on Public Relations.

At our 1952 annual meeting in New York in June, President T. S. Repplier of the Advertising Council forecast the tremendous appeal that *Sparky* would have with the public and announced that the initial newspaper series utilizing *Sparky* as the symbol had received tremendous public support from the newspapers throughout the country.

At our recent 1953 annual meeting in Chicago, Mr. Royal of the Council brought our members up to date on the effectiveness of *Sparky* and predicted that within a short space of time *Sparky* would become a national character.

This fall Mr. Royal's predictions have come true. Geyer Advertising, Inc., of New York, a well known advertising agency, was selected as the volunteer advertising agency for the fire prevention campaign and has turned out a comprehensive national campaign built around *Sparky*. Donald M. Stewart, Advertising Manager of the Texas Company, and the volunteer coordinator of the fire prevention campaign, says: "With the kind of support American business gives its Council campaigns, *Sparky* and his message will become household words this year." This fall the Council has issued a new two-color newspaper proof sheet containing 18 hard hitting fire prevention ads which have been distributed to every newspaper in the country. Already more than 15,000 mats from this series have been ordered from the Council.

Starting with Fire Prevention Week and throughout the year, America's radio-TV industries and their advertisers will contribute generous, big-audience coverage to the campaign. All radio and TV networks, ABC, CBS, Mutual, NBC and DuMont, will carry special programs and literally thousands of forceful announcements teaching fire prevention. Local stations throughout America are providing additional support. Network and regional advertisers cooperating with the Council's allocation plans are carrying fire prevention messages on programs of every type. Special television film spots were issued by the Council with a special TV kit which was distributed to all TV stations and networks throughout the country.

The transportation advertising industry donated 60,000 spaces for a special fire prevention message featuring *Sparky* for display to the millions of riders of the nation's buses, trolleys, subways and ferries, and in November will contribute an additional 55,000 car card spaces.

Large billboard type posters featuring *Sparky* have been contributed by Criterion Service, Inc. and by outdoor and transportation advertising companies for use on station platforms and strategic street locations all over the country throughout the fall.

Every national advertiser, advertising agency, and all of the national magazines, trade papers and house organs of the country have been appealed to by the Advertising Council for support in placing the campaign ammunition built around *Sparky* in advertising space and in editorial space of all such publications.

Through this powerful support of the advertising business in the interest of public service, *Sparky* has become a national character and *Sparky's* messages on fire prevention have been and will be seen by practically every person in the country. The thanks and appreciation of the NFPA are due to the great advertising forces of this country, working through the Advertising Council, for providing us with the greatest opportunity for mass public education in fire prevention ever afforded.

The picture on the previous page is a reproduction of a "Three-Sheet" Sparky poster, 10,000 of which have been placed on outdoor billboards all over the country to urge people to guard against home fires. A limited number of extra copies are available from The Advertising Council (25 West 45th St., New York 36, N. Y.) for posting in schools, fire stations, etc.

The General Motors Fire*

Destruction of the Hydra-Matic automatic transmission plant of the General Motors Corp. at Livonia, Michigan (20 miles from Detroit) on August 12 was the largest industrial fire loss on record. Preliminary estimates placed the property damage between $50,000,000 and $55,000,000. It is impossible to place an accurate dollar value on the many indirect losses resulting from the loss of the only plant making Hydra-Matic automatic transmissions for Cadillac, Oldsmobile, Pontiac, Nash, Hudson, Kaiser and Lincoln automobiles. Three employees were trapped and killed and 15 were injured. A member of the Livonia Fire Department suffered a fatal heart attack and two members of a construction crew were electrocuted while clearing debris several days later; total dead, six.

The general awakening of industrial management to the potentially disastrous results of fire on production was the one beneficial effect of this disastrous fire. Viewing this destruction, many industrial managements are recognizing the interrelationship of production records and fire safety and are facing the well-known fact that fire can reduce production records to zero and in some cases keep them there. As a result of the fire, the head of one large manufacturing plant has told his plant protection supervisor to spare no necessary expense to make their plant safe against a similar loss. This particular company is not one of the largest corporations in the world and in the opinion of its president could not recover from a fire such as that at General Motors.

During and since World War II we have witnessed the development of extremely large-area buildings for industrial production and for warehousing. There have been numerous large loss fires in such buildings, all of which have been recorded, but none of these up to this time has been of such a magnitude as to halt this trend.

The disastrous fire which is the subject of this report happened to occur in a General Motors plant. It could have occurred and still can occur in many other industrial and warehousing operations, both privately and government-owned, in many parts of the country. It is almost fortunate in some respects that this tremendous fire occurred in the property of a company that is financially well equipped to withstand such a loss.

We should like to emphasize that the report of this fire is not intended in any way to be destructive. Our sole interest in reporting on any big fire is to tell as clearly as we can the story of the fire and its lessons so that similar disasters may be avoided in the future. As we have previously stated, General Motors is by no means the only large corporation that has gone along with the trend to larger and larger industrial buildings. We also recognize the fact that General

* Based on information submitted by numerous reliable sources, including the Livonia Fire Department and the Michigan State Fire Marshal.

A. P. Newsphoto

Several thousand gallons of flammable liquids in metalworking equipment and 2,000 tons of tar and asphalt on the roof were the fuels for the fire that destroyed this undivided 34.5-acre "noncombustible" building. According to Business Week (issue of August 22), "The fire at Livonia has changed the course of the entire automobile industry. As a result of the Livonia production stoppage, the industry may turn out 300,000 fewer cars in this model year than it had planned. The loss: about $750,000,000 of sales." This estimate by Business Week magazine may or may not be factual, but the fire undeniably affected automobile sales programs.

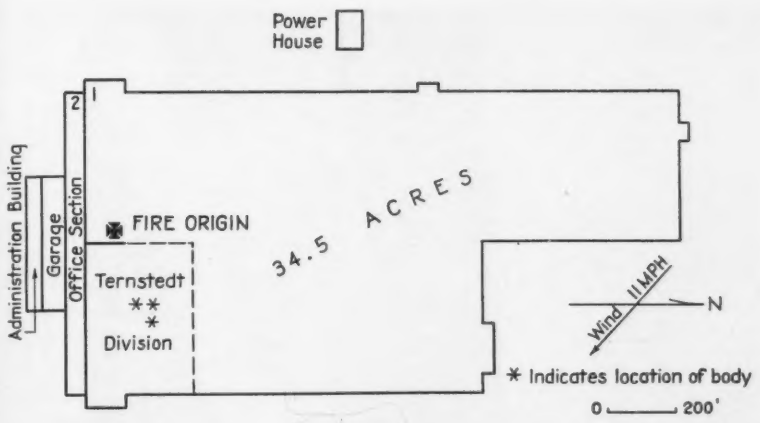

Diagram (showing general features only) of the Livonia, Michigan, plant of the General Motors Corporation. The bodies of three of the six persons who died as a result of the fire were found at the locations indicated.

Motors has held a long-time interest in industrial fire protection matters. The NFPA has long enjoyed fine cooperation and support from this great corporation.

It is perhaps comforting to reflect that it is a sad fact but a true one that it seems to take a major disaster to bring about adequate recognition of fire safety measures. We have the feeling that the night club fire in Boston of a few years ago, tragic as it was, may have brought about a net reduction in loss of life from fire in night clubs. As a result of that fire practically every night club in the country was checked for fire safety. We have the feeling that after the great hotel and hospital fires with tragic loss of life a net gain may have been recorded because hotels and hospitals everywhere have been made safer for the public. Here again, perhaps the net result of the General Motors fire will be an improvement in fire protection and fire safety throughout industry because the lessons of this fire re-emphasize the fundamentals of fire safety that are needed to protect our great industries and to assure their ability to maintain uninterrupted production.

The General Motors Corp. fire started when flammable liquid was ignited by sparks from a cutting torch operation, a preventable but rather frequent cause of fires in industrial plants. The fire could have been confined and extinguished with little damage and with no appreciable work stoppage. Instead, the plant was destroyed and some 32,000 employees of General Motors alone were laid off during the two weeks following the fire. To answer the all-important "Why?" it is necessary to know something about the building construction, processes and arrangement, and private fire protection at this plant, for weaknesses in these features combined to cause the disastrous loss.

Description of the Plant

The building involved in the fire was 1-story high except for the 2-story office section at the south end (see diagram),

for the fire that destroyed this undivided 34.5-acre "noncombustible" building. According to Business Week (issue of August 22), "The fire at Livonia has changed the course of the entire automobile industry. As a result of the Livonia production stoppage, the industry may turn out 300,000 fewer cars in this model year than it had planned. The loss: about $750,000,000 of sales." This estimate by Business Week magazine may or may not be factual, but the fire undeniably affected automobile sales programs.

United Press Photo

This view, looking toward the west wall of the plant, shows the ineffectiveness of manual fire fighting. Hose streams could penetrate no farther than 50 to 75 ft. into the 866-ft.-wide building. The south 400 ft. of the building was involved and parts of the roof had collapsed when the first engine companies arrived.

and a 2-story section at the east side (not shown in diagram). The building had a single fire area of 1,502,500 sq. ft. The only parts of the manufacturing area not destroyed were the 2-story sections. Construction was predominantly noncombustible, consisting of unprotected steel trusses supported by unprotected steel columns located at intervals of 40 ft. north-south and 48 ft. east-west and exterior brick apron walls with large areas of plain glass windows in steel frames. The flat roof, which had much to do with the spread of fire, consisted of a roof deck of narrow plates of No. 18 (U.S.) gauge steel (see photo, page 117) with exterior covering and insulation of built-up layers of asphalt-saturated felt with asphalt mopping between plies, three-quarter-inch-thick fiberglas, several layers of tar-saturated felt with pitch mopping, and a tar and gravel top surface. There were over three pounds of tar, asphalt and pitch per square foot, or more than 2,000 tons on the entire roof. Except for the most easterly and most westerly north-south bays, which were 28 ft. high, the distance throughout the plant from floor to roof was 21 ft. and from floor to bottom chord of trusses 15 ft. The roof was continuous without means of venting a fire.

Occupancy

Two divisions of the General Motors Corp. occupied the building, most of the area being used by the Detroit Transmission Division for the manufacture of Hydra-Matic automatic transmissions. The Ternstedt Division occupied the relatively small area (approximately 133,000 sq. ft. or 9 per cent of the whole) in the southeast corner of the building for manufacture of gun range finders. The boundary of the Ternstedt Division extended 320 ft. north from the office section along the north-south center line of the building and then extended at right angles eastward to the east wall. A 15-ft.-high hollow concrete block wall (see photo, page 113) extended from the office section along the north-south dividing line between the two Divisions for 120 ft. Steel mesh fence about 12 ft. high, with the lower five feet covered with sheet metal plate, extended along the rest of the boundary.

The building had over 3,000 metalworking machines which, although themselves noncombustible, in many instances contained lubricating oils, cooling oils and cutting oils. Heat treating departments scattered throughout the plant contained small quench tanks. There were three 400-gallon wash tanks and three 450-gallon dip tanks of rust inhibitors. In addition there were drums of liquids scattered throughout the plant. The amount of flammable liquids in machines and drums totalled several thousand gallons, but for the most part it was in containers, such that fires might be easily controlled by properly designed equipment.

In the immediate vicinity of the point of origin of the fire was a dip tank containing 450 gallons of rust inhibiting liquid having a flash point of 97.7°F., a drip pan 120 feet in length for this liquid, spot welders, milling and cutting machines and drill presses. Several of these machines were spark-producing.

The processes in the heat treating areas were such that an oily condensate tended to accumulate on the underside of the roof, on structural members and elsewhere.

Livonia Fire Department

Several carbon dioxide and dry chemical extinguishers and a 1½-inch hose stream were used by employees in an effort to control fire that burned in the overhead drip pan.

Livonia Fire Department

Air-conditioning equipment and other machinery, including electrical transformers that had been installed on the roof, fell into the fire when the roof collapsed.

Private Fire Protection

In a building containing quantities of flammable liquids and other combustibles, many ignition sources and no interior fire cut-offs, such as at Livonia, the necessity for complete sprinkler protection should have been apparent. Not more than 20 per cent of the plant was sprinklered, protection being confined primarily to loading, unloading, and shipping areas. There were no sprinklers in the manufacturing area within several hundred feet of the point of origin of the fire.

It might be assumed that a plant of this size, importance and vulnerability would have a strong private fire brigade but here again evidence indicates that strong protection had not been provided. In the Transmission Division (the building was four years old), three weeks prior to the fire the Livonia Fire Chief had been asked to assist in a training program for the fire brigade. He had been unable to start the program before the fire due to previous commitments. The Ternstedt Division had a fire brigade whose members fought valiantly although to no avail to keep the fire from their Division. The extent to which members of either brigade had had training is not clear. For example, did fire brigade members have respiratory protective equipment since in such a building it could be expected they would have to operate in smoke? Did they know how to use such equipment? Were those in charge of the brigade trained or experienced in dealing with similar fire situations?

Water for the plant was supplied through a 10-inch metered connection to a 12-inch looped city main which under normal conditions supplied water at 55 pounds per square inch. Water was raised by two electric pumps in the power plant to a 200,000 gal. gravity tank and from there flowed through two mains: one, a domestic use 6-inch main, and the other, a 10-inch fire service looped main that supplied the sprinkler systems, standpipes and 20 yard hydrants. The tank connections were arranged so that 100,000 gallons was reserved for a fire supply.

Other fire protection included several standpipes with 1½-inch hose attached, several 20 lb. carbon dioxide extinguishers, three 150 lb. dry chemical extinguishers, several manual and at least two automatic carbon dioxide extinguishing systems installed on equipment containing flammable liquid. One of the automatic carbon dioxide systems was installed on the 450-gallon dip tank near the point of origin of the fire, but the system did not protect the overhead drip pan, 120-ft. long and U-shaped, extending from the dip tank. Neither was any other manual or automatic fixed protection provided for this not readily accessible hazard.

In other words, the flammable liquid hazard was recognized but the protection provided was not adequate. Above all, sprinkler protection was not complete.

Origin and Spread of Fire

Sometime before 3:50 P.M. (reports vary) fire caused by sparks from an oxy-acetylene cutting torch operation by a contractor's welding crew broke out in the described conveyor drip pan in the Transmission Division of the plant, 96 ft. north of the office section and adjacent to the hollow concrete block wall separating the Transmission and Ternstedt Divisions. The metal drip pan was 2 ft. wide with a 2-inch lip on either side and for the most of its 120 ft. length was 10 ft. 8 in. above the floor. It ex-

tended beneath a long monorail conveyor that ran just beneath the lower chord of the roof trusses but dropped down sufficiently at the dip tank to immerse metal parts in the 97.7°F. flash point rust inhibiting liquid. The conveyor was operating when the fire broke out, accounting for the fact that the drip pan contained a layer of flammable liquid drippings, probably less than ¼-inch deep.

The fire was discovered by one of the four-man welding crew and was immediately attacked with two carbon dioxide extinguishers from a ladder belonging to the welding crew. The conveyor had been stopped and the fire was being controlled and apparently was about to be extinguished when the extinguishers were emptied, after which flames spread the length of the 120-ft.-long overhead drip pan. Other carbon dioxide extinguishers were obtained and employees came over to assist, bringing with them three 150 lb. dry chemical extinguishers and within a few minutes various employees and the welding crew were doing what they could with portable equipment and a 1½-inch hose line. However, due to the location of the fire overhead about all that could be accomplished was to prevent fire from extending down the slopes of the drip pan into the dip tank. Fog nozzles with applicators, which could have reached the overhead fire, are not mentioned as being available.

During the early part of the fire the ventilating units continued in operation, a blessing from the standpoint of the employees since smoke and heat were carried away, but on the other hand a factor contributing to the spread of fire since operating ventilating fans and the absence of roof vents caused heat and smoke to be carried to other parts of the plant. While employees were making an ineffective attack, the drip pan, roof trusses and roof deck were gradually becoming hot. At about the time the drip pan warped and spilled its flaming contents on the floor, the oily condensate on steel roof members in a nearby heat-treatment area ignited, adding fuel to heat the roof deck.

The employees remaining to fight the fire in the Transmission Division used several 1½-inch streams and the members of the fire brigade in the Ternstedt Division were doing everything in their power to keep the fire from spreading over the concrete block wall into their section of the building. Little headway could be made in either location, however, and soon hot tar and asphalt were flowing through cracks between strips in the heat-warped roof deck and igniting.* The fire then spread laterally behind the increasing area of melted tar that oozed through the roof and simultaneously several fires broke out on machinery, in flammable liquid containers and on the wood floor as hot tar dropped down. As fire fighters ran for safety, many were burned by hot drops of tar and three, including the Ternstedt Division fire brigade chief, were trapped and killed. Two were found in a toilet room and one in a locker room where they had apparently sought shelter.

Evacuation

No information could be obtained as to just how or when the 4,200 employees were alerted to evacuate the building but it must have been reasonably prompt.

* Asphalt as used in a built-up roof covering will not support its own combustion. Asphalt will melt and burn if put in a frying pan with heat under it and that was essentially the situation.

Livonia Fire Department

Photo shows the remains of concrete block wall that extended along part of the boundary between the Transmission and Ternstedt Divisions. Three men at the left of the wall (center of photo) are surveying the point of origin of the fire.

Had evacuation been delayed until the building became untenable due to heat, smoke and falling drops of burning tar and asphalt, there undoubtedly would have been a much longer list of casualties, and possibly panic, since the distance from the interior area of the plant to any of the 83 exits was much greater than recommended by the NFPA Building Exits Code. Casualties were for the most part confined to fire fighters, and according to an informal report prepared by the General Motors Corporation, the manufacturing area of the plant was evacuated of personnel in an orderly manner and in a very short period without panic. An alarm system was used to alert employees in the Ternstedt Division but there is no evidence of an alarm system in the Transmission Division.

Professional Fire Fighting

There is a wide range in the estimates of the time from the start of the fire to notification of the Livonia Fire Department at 3:56 P.M. On the basis of interviews with observers, the Michigan State Fire Marshal believes that there was a delay of between 15 and 20 minutes before one of the plant protection men used the only means available, a telephone, to notify the Livonia Fire Department of the serious fire at the General Motors Plant. A spokesman for General Motors fixes this elapsed time as six minutes.

Three Livonia engine companies were dispatched to the fire at the same time that assistance was called from Redford Township, Plymouth City, Plymouth Township and Wayne. After these calls

were made, Chief Calvin Roberts of Livonia went to the scene and on observing the extent of the fire immediately asked for equipment from Northville, Dearborn and Detroit.

Upon arrival the Livonia fire companies found the entire southern 400 ft. of the manufacturing area in flames and several employees trapped in the second story of the adjoining and communicating office section. One engine company helped plant personnel get these people out. Due to the heavy black smoke and the fact that the central part of the roof had already collapsed and pulled parts of outside walls off plumb, it was impossible for firemen to enter the building. Twenty hose streams were put in operation on all sides but since the building was 866 ft. wide and hose streams could penetrate only 50 to 75 ft., manual fire fighting had little effect. Fire spread unhampered beneath the roof, causing the roof to collapse as it progressed and showering the floor with flaming tar as it gradually involved all parts of the undivided factory area. The fire could not be extinguished and finally burned itself out the following day.

When heat reached sprinklered areas many sprinklers opened but due to the intensity of the fire, sprinkler discharge was ineffective. Collapse of sections of the roof broke sprinkler and other piping. To conserve water, the fire department therefore closed valves on pipes entering the building early in the fire. Fire department pumpers were able to supply seven hose streams from yard hydrants. Four pumpers took suction from city hydrants and three from a small stream that ran by the plant grounds.

Livonia Fire Department

The fire originated in the 120-ft.-long drip pan, part of which is shown collapsed on the dip tank. The carbon dioxide protection for the dip tank was not extended to protect the drip pan nor was any other special protection, e.g., foam or water spray, provided for this relatively inaccessible hazardous area.

Cause of the Fire

At the time of the fire four employees of an outside contractor were cutting and welding a steam line in the Transmission Division about 30 inches beneath the roof and running parallel and adjacent to the concrete block wall separating the two Divisions. Two of the crew were overhead cutting the pipe while the two others were on the floor, one holding the ladder and the other stationed 15 ft. away with a 20 lb. carbon dioxide extinguisher to spot and put out fires caused by sparks. It is said that a large nonflameproofed tarpaulin had been placed directly beneath the cutting operation but, if so, the sparks went through it since the fire started in the drip pan directly beneath.

Factors Responsible for Loss Summary

The following fire protection weaknesses, as indicated in this report, combined to cause this disastrous loss. An effort has been made to indicate by the order of listing the importance of these weaknesses; it is recognized that the relative position of the factors is a matter of opinion.

1. An undivided fire area of 1,502,500 sq. ft. (34.5 acres), in which absence of fire walls and roof vents denied access for fire fighting and prevented localization of heat and smoke.

2. Inadequate sprinkler protection (only 20 per cent of the total area protected—no sprinklers where the fire started).

3. Incompletely engineered processes. Fire protection for the dip tank did not protect the drip pan. Due to the processes, oily deposits had a tendency to accumulate and increase the fire hazard of the several heat-treating areas, yet this condition does not appear to have received engineering attention.

4. Unprotected steel construction, in particular the thin steel deck that did not offer sufficient insulation between banking heat and the built-up roof covering to prevent asphalt from melting and dripping through joints of the heat-warped deck. Steel trusses collapsed in a matter of minutes.

5. Use of oxy-acetylene torch under unsafe conditions.

6. Lack of an effective private fire brigade.

7. Delayed fire department notification.

Similarity of Other Fires

To anyone under the misapprehension that the devastating effect of these fire protection weaknesses has been previously unknown to fire protection engineers, the following statistics from the analysis of 1952 large loss fires (individual losses $250,000 or more) published in the January 1953 NFPA QUARTERLY will be of interest. Excessive areas without fire division walls were noted as contributing factors in 66 per cent of the large loss industrial fires. In 32 per cent, flammable liquids contributed to the spread of fire, and in 70 per cent of the plants automatic protection was lacking. Lack of employee training resulted in delayed alarms being sent to the fire department in 21 per cent of the cases,—most of

the delay being occasioned by efforts of the occupants to fight the fire with extinguishers before calling for professional aid. Lack of a strong, organized private brigade when the emergency arose contributed to nine of the losses. In eight large loss fires in unsprinklered buildings heat from burning contents or from burning combustible parts of the building caused unprotected steel structural members to collapse. Welding or cutting sparks caused four of the fires. In two cases lack of reliable fixed protection for dip tanks allowed fire originating at dip tanks to spread beyond control.

Pertinent NFPA Fire Protection Recommendations

To aid plant managements throughout the world who are re-assessing the fire safety of their plants as a result of the General Motors Corp. fire, the following fire protection recommendations from NFPA publications and relating to the particular fire protection weaknesses that combined to cause the Livonia disaster are set forth. Detailed recommendations for correction of these and other fire protection weaknesses inherent in industrial plants are published in NFPA Recommended Standards.

Building Areas

Large areas are commonly permitted in one-story buildings, which present a far simpler problem in fire fighting than multi-story buildings, but it is not good practice to permit excessive areas, owing to danger of fire in the contents, even in buildings of the best types of construction. Life safety from fire in buildings of very large areas also imposes special problems. In buildings of conventional shapes exceeding 100,000 sq. ft., it is impossible to provide direct outside exits within the maximum distances specified by the Building Exits Code*, and compliance with exit requirements involves various expedients which may introduce undesirable complications. *NFPA Handbook of Fire Protection.*

Sprinkler Protection

Sprinklers should be installed throughout the premises. *Standards for the Installation of Sprinkler Systems.* (*NFPA Pamphlet No.* 13.)

Where flammable liquids are used in moderate quantities automatic sprinklers may be depended upon to hold fires in check. Experience shows good results from automatic sprinkler protection even under many severely hazardous conditions.

The cooling effect of water discharged from sprinklers, especially under good pressure, is sufficient under many conditions for the control or prompt extinguishment of flammable liquid fires, but where such liquids are used to any material extent, the conditions should be carefully studied and special safeguards provided. *NFPA Handbook of Fire Protection.*

Noncombustible Building, Moderate Fire Load

The principal advantage of the unprotected noncombustible structural type as compared to combustible types is its freedom from the spread of fire throughout the roof structure. This type is therefore safe for use in a wide variety of industrial and other types of buildings where the occupancies are of low hazard, or where the high hazard sections of the occupancy are effectively cut off from the remainder of the noncombustible structure. Automatic sprinklers or other forms of protective devices should be provided to prevent serious structural damage in the event of fire if there is more than slight fire load in noncombustible buildings. *NFPA Handbook of Fire Protection.*

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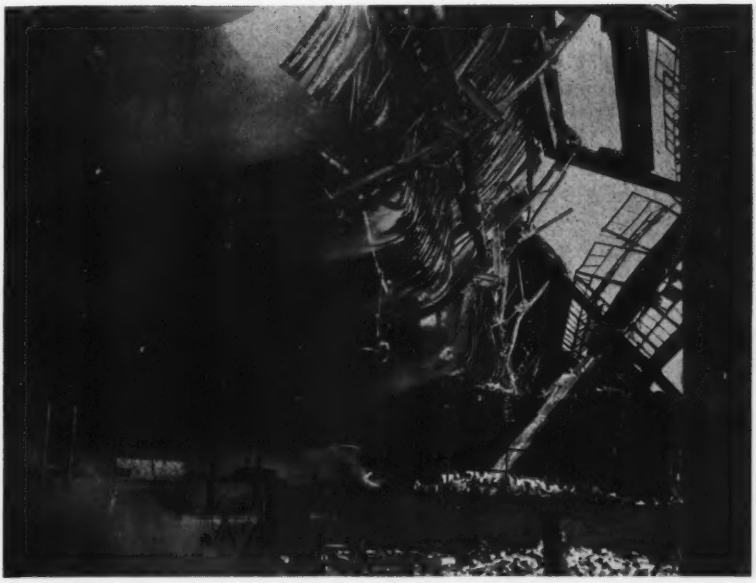
*Building Exits Code, published in separate pamphlet and in National Fire Codes, Vol. III, available from the National Fire Protection Association, 60 Batterymarch St., Boston 10.



Detroit Free Press

The roof deck, consisting of 18-gauge steel strips, was warped and cracked by heat from fire in the drip pan and from burning oil condensate on steel roof supports. Melted tar and asphalt came through the cracks and added fuel to the fire.

Cutting and Welding

Welding and cutting fires are preventable. The safest and surest rule to follow in preventing fires is to keep flames, sparks, molten slag and hot metal from coming in contact with materials that will burn — an elementary precaution seemingly, but the one most frequently ignored.

The precautions which are taken for any situation must be adequate for the particular conditions present. A number of fires have occurred where the hazard was recognized but where the precautions which were taken were inadequate and not properly planned to give the safety desired. *Preventing Cutting and Welding Fires.* (*NFPA Pamphlet No. D* 36.)

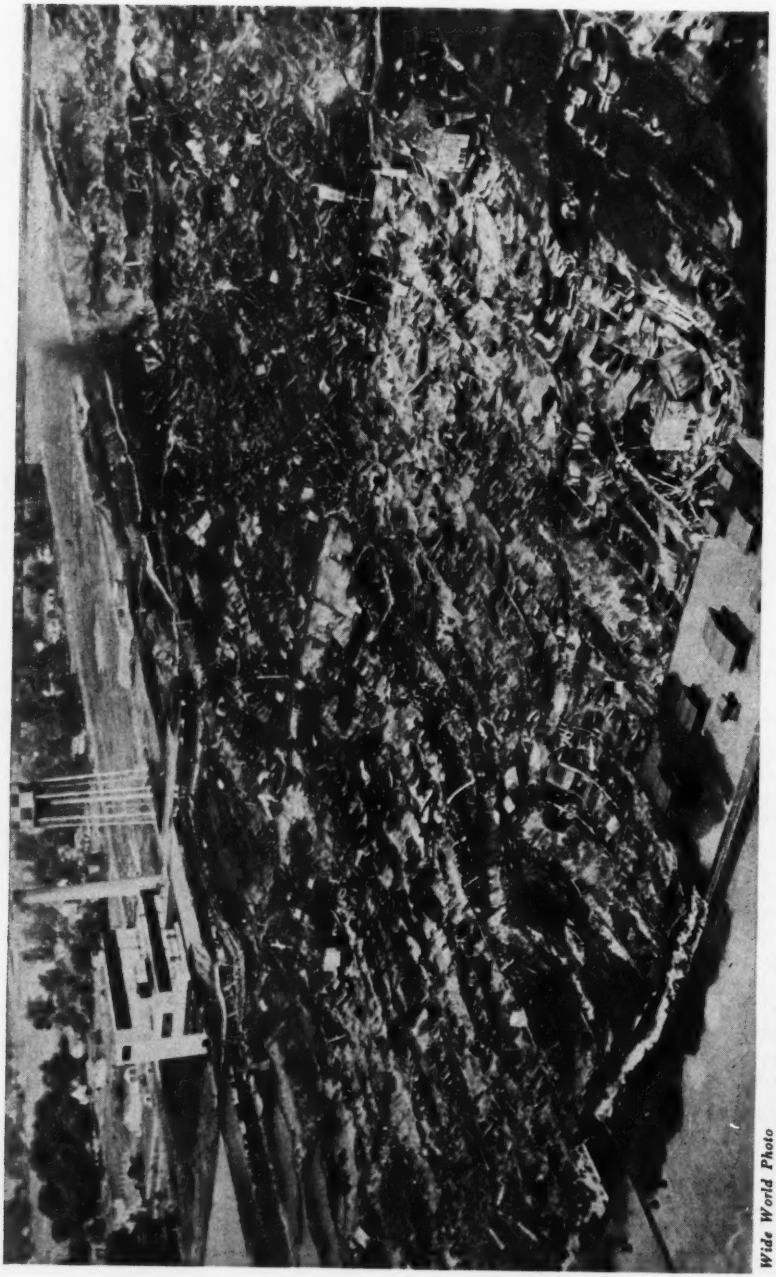
There shall be no open flames, spark producing devices, or heated surfaces having a temperature sufficient to ignite vapors in any vapor area.

Primary emphasis should be placed on supervision by a qualified individual such as a welding superintendent, maintenance foreman, fire chief, plant engineer, or master mechanic. He should examine the location of any proposed work; insist on other methods if conditions are not safe, and specify the precautions which must be taken. *Standards for Dip Tanks Containing Flammable or Combustible Liquids.* (*NFPA Pamphlet No.* 34.)

Protection for Dip Tanks

Dip tanks of all sizes can be effectively protected by foam or carbon dioxide or water spray systems. *NFPA Handbook of Fire Protection.*

Automatic carbon dioxide systems shall conform to NFPA standards for Carbon Dioxide Fire Extinguishing Systems (NFPA Pamphlet No. 12) and shall be arranged to protect both dip tanks and drain boards and unless stock over drain boards is otherwise protected with automatic extinguishing facilities, shall be arranged to protect such stock. *Standards for Dip Tanks Containing Flammable or Combustible Liquids.* (*NFPA Pamphlet No.* 34.)



Wide World Photo

Aerial view looking northwest. The 2-story office sections were the only parts of the undivided 1,502,500 sq. ft. building not destroyed. The detached power house is at left center.

Aerial view looking northwest. The 2-story office sections were the only parts of the undivided 1,502,500 sq. ft. building not destroyed. The detached power house is at left center.

Oily Condensate on Structural Members

Buildings, or rooms or other enclosures in which Class I or Class II flammable liquids are used or stored in open vats or dip tanks shall be provided with ventilation sufficient at all times to prevent accumulation of flammable vapors. *Suggested Ordinance for the Storage, Handling and Use of Flammable Liquids.* (*NFPA Pamphlet No.* 30-L.)

Fire Brigades

A fire brigade should be organized in all establishments.

In larger plants or shops, the manager may designate one employee as fire chief and other regular employees may be organized in a group designated the fire brigade. In most plants the frequency of fires will not be great enough to require permanent firemen, but some very large plants will require a fire department organization as complete as that of a municipality. *Suggestions for the Organization, Drilling and Equipment of Private Fire Brigades.* (*NFPA Pamphlet No.* 27.)

Fire Department Notification

A fire brigade should be organized, drilled and maintained with the idea that fires shall be controlled quickly. The person nearest to the fire should give the local alarm immediately and notify the local public fire department, if means are available. Suitable arrangements should be provided for promptly calling the nearest local public fire department, by means of a fire alarm box, or by other method appropriate to local conditions. *Suggestions of Private Fire Brigades.* (*NFPA Pamphlet No.* 27.)

Dispersion of Essential Processes

In addition to the seven itemized fire protection weaknesses that combined to make the General Motors Corp. fire the worst industrial fire in history, the "all eggs in one basket" policy of manufacturing all Hydra-Matic transmissions in an area subject to total destruction by a single fire was a costly violation of a fundamental rule of fire safety. The following quotation from *Fire Defense** is one of several in NFPA publications enunciating this fundamental. "One should start with the assumption that any building of a plant by the most adverse combination of circumstances may be completely destroyed by fire. This is certainly important in wartime when abnormal conditions may be expected. The manufacturing processes must therefore be arranged so that loss of one or more buildings does not cripple production."

The Problem for Top Management

Top executives of industry are undoubtedly wondering whether they have a situation like the one illustrated by this fire in the plants of their own company or companies. To them the following may be said:

Take a fresh look at processes of your plants. At least make a spot check.

Start by considering the relative combustibility of raw materials and the problems of handling them. Find out if in any important respect the methods of handling and storage deviate from a reasonable safe practice.

Satisfy yourself on this point. If your staff people can't satisfy you, it would be money very well spent for you to hire a competent outside expert.

Use the same approach for each manufacturing process and for the warehousing of finished products. Write for a list of the 180 published standards and other publications of the National Fire Protection Association and from these select

*First published by the National Fire Protection Association in 1941. Out of print.

those applicable to your plants and study your procedures in the light of the recommendations of these standards.

Evaluate each unit not only from the point of view of the value of that unit but based on its part in the operation as a whole. If the loss of that unit will severely handicap the entire operation it should be subdivided, or where this is not possible the maximum degree of fire protection should be provided.

Have someone prepare for you a list of all large buildings in your plants. Ask them to include large outdoor storage areas in this list. The list should include all buildings of 40,000 sq. ft. or more, all of 5,000 sq. ft. which are not completely protected by automatic sprinkler systems, and all buildings housing materials or processes of which there are no readily available duplicates. This is another method of putting your finger on the "all eggs in one basket" situation.

The list of buildings over 40,000 sq. ft. will flag your own cases where single fire areas may be excessive or where the total amount of combustible per sq. ft. may be unreasonably large considering the arrangement of the building and the type of building construction which has been chosen for it.

There must be a very unusual set of circumstances to justify the use of any manufacturing area without sprinkler protection and the list of unsprinklered buildings should be carefully reviewed. Buildings which are partially sprinklered may be evidence that someone is falling down on the job.

In checking on sprinklered property look into the details of water supply including gravity tanks, yard systems, fire pumps, central station supervision.

Check the organizational set-up for handling fire prevention and fire protection matters in your companies and appraise the competence of personnel assigned to these responsibilities.

In the central management, find out if a competent fire protection engineer is employed at a management level high enough to make his influence felt. If fire protection engineering decisions are made by an executive whose background is safety, legal or personnel work, for example, or even in a branch of engineering which does not include fire engineering experience, you may not be getting the best possible advice.

Check also the measures by which central management keeps posted on fire conditions in all plants of the companies associated in the central management. You may find some plant doing some things for fire safety which other plants are not. Find out why.

In the individual plant, find out if there is a fire protection supervisor, a routine for inspection and maintenance of fire protection equipment, a properly directed and trained fire brigade, and if suitable arrangements have been made with the public fire departments.

Find out if there is a fire control program under the direction of department heads as well as for the plant itself. Each department should have a program for promptly controlling small fires, for protecting records, and for emergency evacuation of the department. Check employee attitudes towards these measures.

A helpful publication going into further detail on organizational matters is entitled, "Employee Organization for Fire Safety," published by the National Fire Protection Association (1950, 44 pages).

NACA Aircraft Crash Fire Tests*

By I. Irving Pinkel, G. Merritt Preston and Gerard J. Pesman
National Advisory Committee for Aeronautics

Full-scale aircraft crashes, devised to give surge fuel spillage and a high incidence of fire, have been conducted by the National Advisory Committee for Aeronautics at their Cleveland Lewis Flight Propulsion Laboratory during the last 4 years. The tests were designed to investigate the mechanism of the start and development of aircraft crash fires. The results are discussed herein.

Introduction

Recent aeronautical-medical research has shown that the ability of the human body to withstand rapid deceleration without serious injury depends upon the length of time during which the body is subjected to the force of deceleration. A greater deceleration force can be withstood for a very short time than can a more moderate deceleration for a longer period. In many aircraft crashes, high decelerations often exist for only extremely short periods of time, indicating that worth while gains in crash survival might be realized if the fire that often accompanies crash was avoided. Acting on the recommendation of the National Advisory Committee for Aeronautics Committee on Operating Problems and the Subcommittee on Aircraft Fire Prevention, the NACA Lewis Laboratory has engaged in this study. It is intended to provide a factual background on which features of aircraft design can be modified which may reduce the likelihood of fire following crash and improve the chances for escape or rescue should the fire occur. Although this study is ultimately to include aircraft powered with the various types of turbine engines as well as reciprocating engines, the present report covers only the work completed on reciprocating engine aircraft.

The current crash-fire study began in 1949 with a review of past crash accidents, civil and military. The investigation of crash-fire accident records, however, failed to reveal well-defined mechanisms for crash fire, primarily because the pertinent physical factors acting to initiate the fire are often obscured from view or too short-lived to be reported accurately by eyewitnesses. Fire damage, likewise, obscured the true nature of the disruption suffered by the aircraft resulting in fuel spillage and generation of ignition sources. The need for conducting full-scale crashes under conditions which permit careful observation of the successive events in the crash was apparent from this accident study.

Acquisition of service-weary twin-engine cargo aircraft from the U. S. Air Force for full-scale crash research made possible the analysis of the mechanism of the crash fire discussed in this report. Photographs of the low-wing C-46 aircraft and the high-wing C-82 aircraft used in this study are shown in Figures 1 and 2 respectively. A few of the features of each aircraft, to which later ref-

*An extract of NACA Research Memorandum E52F06 dated August 28, 1952 (Classification Cancelled Feb. 27, 1953). Reproduced by special permission of the National Advisory Committee for Aeronautics.

erence will be made, are indicated in the figures. Of the 17 full-scale crashes conducted in this program so far, four were C-46 aircraft and 13 were C-82.

Because it was desired to study the mechanism of crash fires under crash circumstances which approximate real conditions, a crash barrier was designed to impose the gross damage to the aircraft similar to that which may occur in unsuccessful take-offs and landings in which severe engine damage and major fuel spillage occurs. Aircraft crashes at flight speed into obstructions such as buildings and mountain-sides usually involve a degree of aircraft disintegration so severe that design measures or equipment arranged to reduce the likelihood of fire are rendered impotent. For this reason, attention in this study is focused on crashes which occur at take-off and landing speeds where the likelihood of personnel surviving the impact is high and design safety features and crash-fire protection equipment that may be employed have a reasonable chance to serve their function.

The results of the current work are limited to those features of aircraft crash fires that have been investigated in this program. While an attempt has been made to include in this study as many factors involved in crash fires as past experience and current results have revealed, undoubtedly there remain areas that have not been covered in this work.

Test Arrangements

The crash-fire problem was studied by conducting full-scale crashes with the twin-engine cargo aircraft illustrated in Figures 1 and 2, each instrumented to record significant data in the crash and fire that follows. The instrumentation analyzed (1) fuel spillage, (2) combustible-vapor distribution in areas adjacent to potential ignition sources, (3) locations and timing of electrical system ignition sources, (4) fire incidence and progression, (5) temperatures and toxic-gas concentrations in personnel compartments, and (6) the decelerations the several main components of the aircraft undergo in the crash. High-speed motion pictures of the

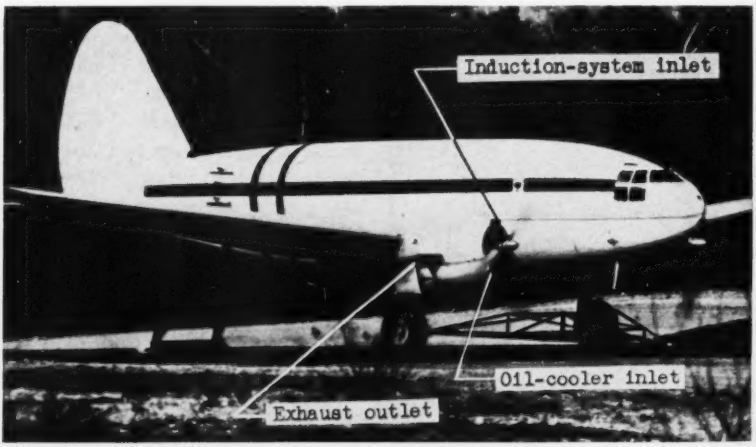


Figure 1. C-46 aircraft used in the aircraft crash fire test program. Note that aircraft is mounted on track but that all component parts except tail wheel are present.

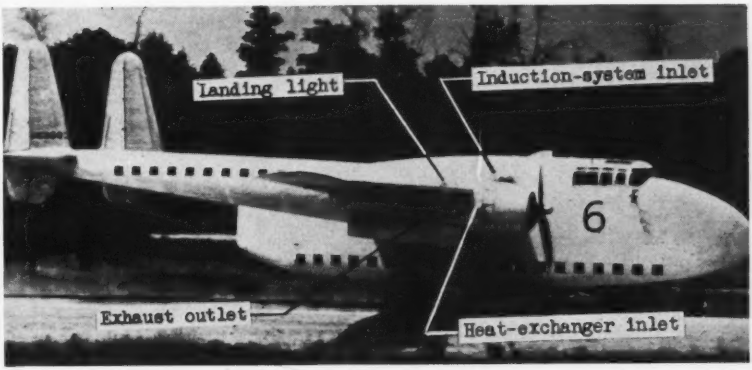


Figure 2. C-82 aircraft used in crash fire testing work. The aircraft was complete except for the nose wheel which was replaced to guide the aircraft down the runway rail. The square markings on the fuselage were to aid in estimating aircraft speeds by photographic methods.

crash tests were obtained which revealed many of the details of the mechanism of crash fires.

The arrangements for conducting the full-scale crash study are shown in Figures 3.a. and 3.b. The monorail guided the aircraft, which was accelerated from rest under its own power, to the obstructions shown in the diagram and photo. Aircraft speed upon impact with these obstructions ranged from 80 to 100 miles per hour. The abutments in the path of the landing wheels stripped the landing gear from the aircraft. The height of the abutments was adjusted to permit the striking aircraft propellers to produce extensive nacelle damage short of breaking out the engine. In this way the generation of ignition sources by the engine was promoted. Poles arranged to rip into the wing leading edges and wing fuel tanks about 5 feet outboard of the nacelles produced fuel spillage that was distributed extensively around the crashed aircraft.

The progressive damage to aircraft at the crash barrier is illustrated schematically in Figures 4.a., 4.b., and 4.c. Each aircraft carried 1050 gallons of gasoline or

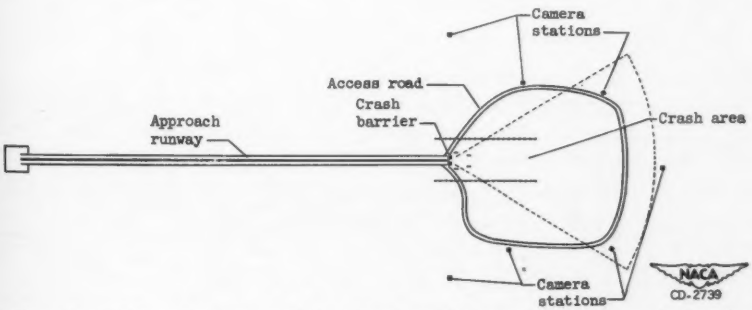


Figure 3.a. Schematic drawing of the aircraft crash fire program test site devised by engineers of the National Advisory Committee for Aeronautics.

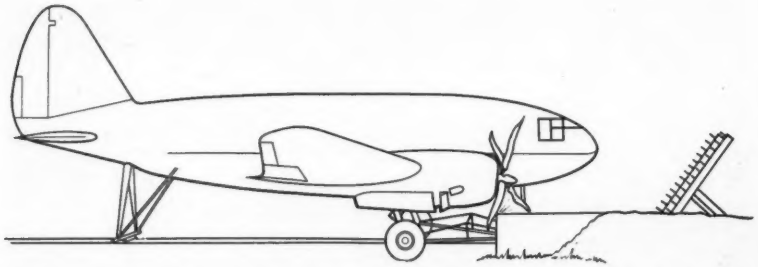


Figure 4.a. Impact of propeller with abutment as aircraft initially strikes the barrier.

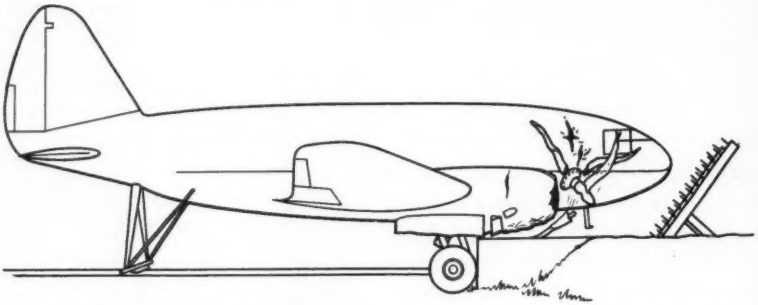


Figure 4.b. Second stage of impact of the aircraft with the barrier showing deformation of engine nacelle, severance of propeller and impact of landing gear.

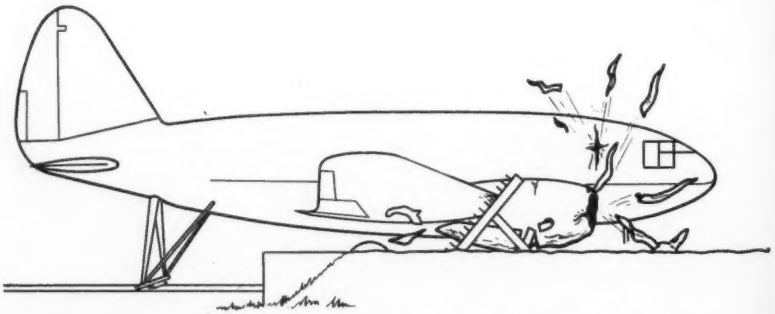


Figure 4.c. Impact of wing with pole barrier which normally resulted in opening of wing fuel tank area and atomization and spillage of fuel.

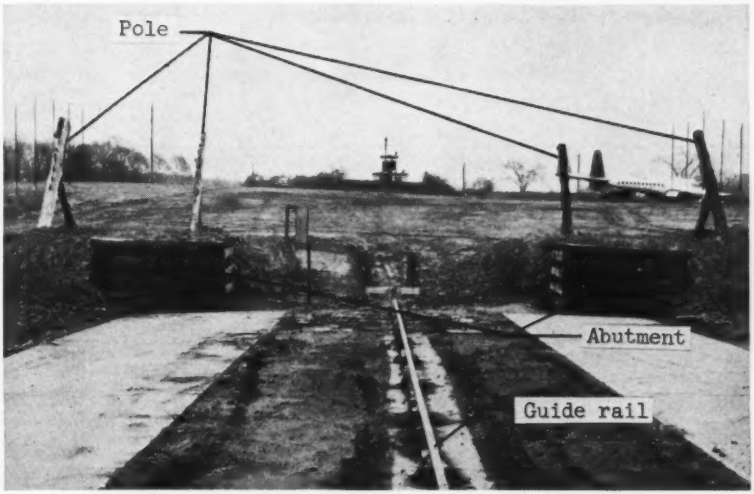


Figure 3.b. Photograph of the runway guide rail, concrete runway strips and the crash barrier used to purposely cause fires at time of impact.

low-volatility fuel described in Table I. The fuel was usually dyed red to improve its photography in color.

Table I — Fuel Analyses

Analysis	Aviation Gasoline 100/130 Grade	Low-Volatility Fuel
Distillation (°F)		
Initial boiling point	104	295
Per cent evaporated		
5	135	330
10	149	335
20	168	340
30	185	343
40	201	345
50	214	348
60	223	350
70	232	354
80	241	357
90	257	364
95	282	369
Final boiling point	330	378
Residue (per cent)	0.6	1.0
Loss (per cent)	0.9	0
Reid vapor pressure (lb./sq. in.)	6.1	0.1
Specific gravity at 60°F/60°F	0.700	0.781
Refractive index	1.3934	1.4374

Ignition Sources — Fuel Contact

Inquiry into the mechanism of the crash fire centers on the answer to two questions: How and when do ignition sources appear in an aircraft crash, and how does the fuel come into contact with the ignition sources? The ignition sources revealed in this study are those which are familiar from experience in normal operations and other technical fields. These ignition sources are tabulated in column 1 of Table II along with the time of their appearance after crash impact (column 2).

In these crashes the fuel was observed to spill in liquid form from broken fuel lines and tanks, as premixed fuel vapor and air from the damaged engine induction systems, and as fuel mist around the aircraft when the spillage appears on the outside of the aircraft while it is in motion. In the latter case, the pressure and viscous forces of the air on the fuel rip it to mist that moves with air around the

Table 2 — Ignition Sources and Inerting Systems — Time Elements

Ignition Sources	Time After Crash Impact Ignitions Observed (Seconds)	Inerting System Components Protecting Ignition Source	Function Time of Inerting System (Seconds)
Hot surfaces			
Exhaust system	1.3	Water spray	0.19
	0.7		
	1.9		
	3.8		
Heat exchanger	12.1	Water spray	0.19
Exhaust flame			
Torching	4.1	CO_2 and water and fuel shut-off	0.34
	1.3		
	2.0		
	3.5		
	1.9		
Exhaust gases	0.1	CO_2 and water and fuel shut-off	0.34
Electric			
Arcs	1.0	Electric shut-off	0.10
Filaments	0.6	None	——
Induction system flames	2.2	CO_2	0.06
	3.5		
	7.7		
Chemical agents (hydraulic fluid, lubricating oil, alcohol)	4.4	All	——
	3.5		
	3.5		
Electrostatic sparks	2.4	None	——

aircraft. In the crash arrangements employed in this study, liquid and mist spillage occurred in every crash and carburetted fuel spillage from the engine induction system in only a few cases. These latter instances, however, were sufficient to reveal how such spillage serves to initiate a fire.

How Fuel Spills Atomize

The fuel that spills to the open air through the breach in the leading edge of the wing can attain appreciable spanwise spread as mist forward of the leading edge of the wing and reach ignition sources located around the nacelle. As the aircraft decelerates in the crash, the fuel opposite the breach in the tank has a speed which is greater than the existing aircraft speed. The fuel surges forward through the breach in the tank and is atomized by the air. The air forces which atomize the fuel to mist also impart a spanwise velocity component to the fuel droplets. As this spanwise velocity component is acquired, the forward velocity declines. If the aircraft is moving rapidly, the aircraft moves by the spreading pattern of fuel mist before the mist has an appreciable time to spread spanwise. If the aircraft moves slowly, the fuel mist attains significant spanwise extension around the aircraft and contact with ignition sources at the nacelle is likely.

The combination of reduced aircraft speed and high aircraft deceleration represents the conditions of aircraft motion most hazardous from the standpoint of fuel mist ignition at the nacelle. A comparison of the small spanwise distribution of the fuel obtained when the aircraft speed is high and the deceleration is low (Fig. 8.a.—8.f., pp.131-132) with the

large fuel mist spanwise development forward of the wing leading edge obtained at low aircraft speed and high deceleration (Fig. 9.a.—9.b., p.132) shows these effects clearly.

Because a few seconds are required for the aircraft to slow from its high speed at crash impact, contact between the fuel mist and ignition sources of the nacelle occurs several seconds after impact. An example of this time delay required for fuel mist contact is given in Fig. 10.a., b., c., d., p. 133. which shows a series of exhaust flames issuing from the engine tail pipe during the aircraft slide from the crash barrier to near rest when ignition of the gasoline mist occurred at the engine tail pipe (Fig. 10.d.). Fig. 11., p. 134. shows the largest exhaust flame (circled) observed during the crash program. Ignition of the gasoline mist by the hot exhaust collector ring, involving a similar time delay, is shown in Fig. 12.b. of Fig. series 12.a., b., c., p. 134.

Low-Volatility Fuel Not Whole Answer

The substitution of low-volatility fuel for gasoline does not materially reduce the likelihood of ignition when contact between the fuel mist and a potent ignition source occurs. The ignition of the mist of low-volatility fuel at the engine tail pipe is shown in Fig. 13.a., p. 135. The large fuel mist fire on the left side of the aircraft (Fig. 13.b., p. 135) followed the ignition 1½ seconds earlier in Fig. 13.a. These results indicate that fuel of low volatility will ignite and burn readily when dispersed as mist, and their adoption for reciprocating engines alone would not represent a wholly acceptable solution to the crash-fire problem.

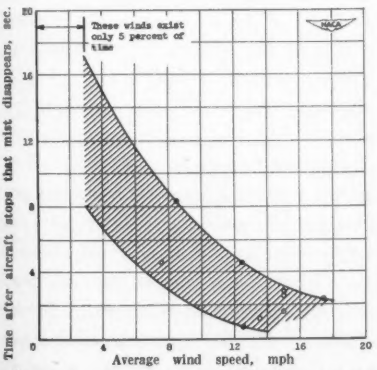


Figure 5. Chart showing the effect of the wind velocity on time after the aircraft stops. Shaded area shows time fuel mist remains around the crash area.

Fuel Mist Influenced by Wind

Because the fuel mists are airborne, they persist in the air around the crashed aircraft for a time which varies inversely as the wind speed (Figure 5.). Fuel mists in ignitible concentrations seldom persist around the aircraft for more than 17 seconds after the aircraft comes to rest. If a tail wind sweeps the mist from the crash area, the likelihood of ignition is momentarily increased as the dense portions of the fuel mist are swept over the nacelle by the wind. Because of the large error inherent in making a visual estimate of the persistence time of the fuel mist in the neighborhood of the aircraft it was not possible to evaluate the effect of fuel volatility on this persistence time.

Fuel vapors associated with the mist will move with the wind approximately as the smaller mist droplets and may have a persistence time a few seconds greater than the bulk mist.

Liquid Fuel Spills to Ground

Transitions from fuel mist spillage to spillage in liquid form in the open air takes place as the aircraft slows to rest. Because of the high rate of air dilution

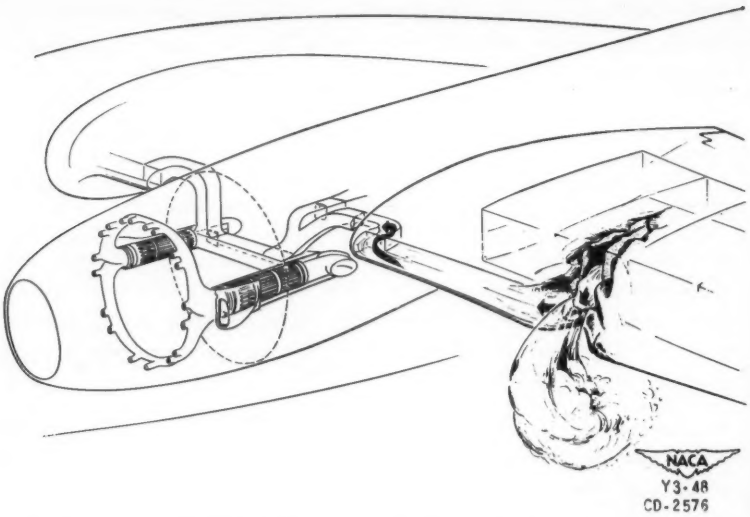


Figure 6. Schematic drawing of anti-icing system showing the path of liquid fuel flowing from wing tanks to heat exchangers. In this way liquid fuel was ignited.

provided by normal air movement in the open, combustible concentrations of gasoline vapors appear only close to the fuel spillage in strata that lie close to the ground. Where protection from wind is obtained by vegetation, ground channel or ditches, or components of the crashed aircraft, a marked increase in ignition hazard distance from the liquid spillage exists. In general, however, the likelihood of ignition of vapors from liquid pools of gasoline in the open air does not appear significant unless the ignition source lies within a few inches of the ground. Except for burning droplets of oil dripping from the nacelle, or broken elements of the exhaust disposal system falling to the ground, the ignition sources can be expected to lie above this combustible layer of vapor.

Liquid Fuel Spills Within Aircraft

Gasoline spilled within the enclosed cavities of the aircraft where low air ventilation rates exist can generate large volumes of combustible concentrations of vapor which can move through the channels provided by the aircraft structure. Fuel in both liquid and vapor form can flow through these channels by gravity and achieve a considerable displacement away from the fuel spillage point. Hot-gas ducts of the icing protection systems or cabin air conditioning for example, lead to heat exchangers which are often at temperatures above the fuel ignition temperature. Fig. 14., p. 135, shows fire that followed the movement of wing-spilled fuel through the icing system hot-gas distribution duct which runs along the wing leading edge to the engine exhaust gas heat exchanger on the engine tail pipe below the wing (Fig. 6. above.). Propagations of the fire into the wing above the path of fuel produced the wing explosion shown in Figure 14. Because of the time required for the fuel to move to

the ignition source, this fire occurred 12 seconds after crash impact.

Ignition By Wing Landing Lights

Ignition sources within the wing belong to the wing electrical system. Damage to this electrical system during crash impact can produce ignition sources close to the wing fuel spillage, and fire follows almost at once. Figure 15.a., b., c., and d., p. 136. shows the fire produced by operating landing lights which are smashed and driven into the wings by the poles at the crash barrier. The wing fire appeared 0.60 second after crash impact.

Fuel Wetting of Aircraft Surfaces

Distribution of fuel in liquid form from the spillage point to remote areas can take place on the lower surfaces of inclined elements of the aircraft structure. The liquid fuel wets and clings to these surfaces, such as the lower wing skin, and flows by gravity. This so-called "wetting conduction" of the fuel tends to move to the nacelle (because of the wing dihedral) and it is here that many ignition sources are located. (This assumes that the wing position is not altered from normal in the crash).

Engine Induction System Spills

The fuel that is spilled as carburetted mixture of fuel and air from the damaged engine induction system is generally released in zones adjacent to the hot exhaust disposal system and the electrical elements in the engine accessory sections. A variety of ignition sources are available, therefore, to ignite this fuel. The quantity of fuel in the engine induction system is too small to produce a serious fire unless the flash fire of this fuel extends to other fuel spillage. In Fig. 16.a., b., c., d., p. 137. is shown the propagation of the engine induction system fuel fire out

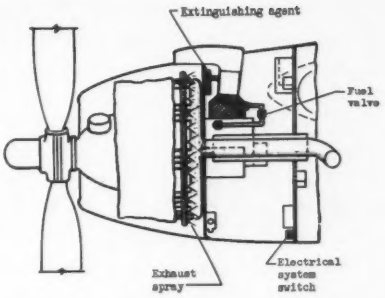


Figure 7. Method used by NACA engineers in inerting ignition sources in aircraft reciprocating engine power plants.

of the nacelle to the fuel spillage from the wing. Fig. 17., p. 138. shows an example of an induction system fuel ignition 3.5 seconds after initial impact.

Fire Inerting System

In an effort to reveal mechanisms of crash-fire initiation that may have been obscured by the early fires set by the known ignition sources, an ignition source inerting system was installed in nacelles of several aircraft crashed in this program. A schematic view of the inerting system arrangements is in Figure 7. above. The four-component inerting system includes a fuel shut-off valve at the carburetor and fire wall which serves to bring the engine to rest, a 3-pound charge of fire extinguishing agent injected with the engine fuel to inert the engine interior, an electrical system cut-off switch on the battery and generation circuits to prevent the development of hot wires and electric arcs, and a water-spray system that is arranged to distribute water to all parts of the hot metal of the engine exhaust disposal system. The steam generated on the hot metal surfaces of the exhaust system provided protection from fuel or oil ignition while the metal cooled to temperatures

below the ignition point of fuel and oil. All components of the system were arranged to be actuated as soon after crash as possible. (See also Table 2., p. 126.)

Five of the aircraft equipped with the inerting system did not burn. A sixth aircraft, likewise equipped, was subjected to a ground loop and did not burn.

Static Ignition Potentials

The only new mechanism of crash fire revealed in this phase of the work with the ignition source inerting system installed in the aircraft nacelles is shown in the crash illustrated in Fig. 18.a., b., c., p. 138. The landing wheel and strut, which were stripped from the aircraft at the crash barrier, followed in the wake of the aircraft sliding along the ground. In its passage through the soil dust and fuel mist in the wake of the aircraft, the wheel and strut accumulated an electrostatic charge, which ignited the fuel behind the aircraft when the wheel strut approached the ground, and discharged its accumulated electrostatic charge (Figure 18.b.). The fuel fire propogated through the fuel in the wake of the crashed aircraft.

Friction Spark Hazard Under Study

The fire-setting mechanism involving friction sparks and friction-heated surfaces is currently under study.

Conclusions

The results of this work indicate that significant reductions in crash-fire hazard can be realized by any design measure which increases the forward and spanwise distance, and elevation, of the engine with respect to the fuel storage. This trend in aircraft component arrangement will reduce the likelihood of contact between fuel in mist form with the many ignition sources at the nacelle.

Devices or design features which act to intercept spilled fuel flowing within the channels provided by the airplane structure are also valuable. Provisions for drainage of the intercepted fuel to spillage points in the open air away from the nacelles would enhance the effectiveness of these arrangements.

Location of landing lights away from chordwise positions in front of the fuel storage is indicated.

Preliminary data suggest the value of employing paints which have a reduced tendency to accumulate electrostatic charge by friction with dust and fuel on the parts of the aircraft likely to be detached in a crash and trail the aircraft.

In an approach to an indicated crash landing, the pilot should de-energize all of the electrical system not required for landing. Engine operation that provides the coolest exhaust disposal system temperature should be practiced. Just before touch-down the fuel flow to the engines should be cut off to allow the engine to purge itself with air before crash impact.

In view of the effectiveness of the experimental ignition source inerting system in preventing crash fires experienced in this study, the desirability of further study of this system for special aircraft applications is indicated. A combined system for both crash and flight fires may be particularly attractive because protection for crash and flight fires may prove to be possible without serious increases in weight over the flight-fire system alone.

Editor's Note: Crash fire extinguishment with ground fire fighting equipment was not included in these tests.

Figure 8.a. Fuel mist shown at arrow; 0.5 second after initial impact. Aircraft speed, approximately 95 feet per second.

Figure 8.b. Oil vapors emerging from nacelles at arrow; 3.38 seconds after initial impact. Aircraft speed, approximately 3 feet per second.

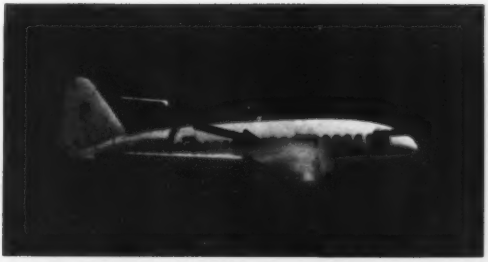


Figure 8.c. First oil fire outside of nacelle at arrow; 3.42 seconds after initial impact. Aircraft speed, 2 feet per second.

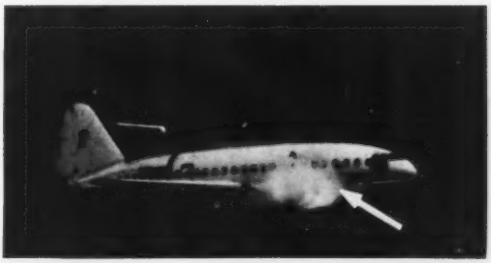


Figure 8.d. Ignition of fuel mist by oil fire; 3.5 seconds after initial impact. Aircraft speed, 0.

Figure 8
Role of Oil Systems in Aircraft Crash Fires

(Series Continued Next Page)

Figure 8.e. Spread of fuel mist f... 5.3 seconds after initial impact.

Figure 8.f. Spread of fuel mist f... 6.6 seconds after initial impact.

Figure 8
Role of Oil Systems in Aircraft Crash Fires

Figure 9.a. Forward fuel mist development (fuel dyed red). Aircraft speed approximately 40 feet per second.

Figure 9.b. Sidewise fuel mist development (fuel dyed red). Aircraft speed about 40 feet per second.

Figure 9
Fuel Atomization at Impact — Aircraft Speed 40 Feet per Second

Figure 10.a. First exhaust flame and spread of fuel mist; 1.1 seconds after initial impact. Aircraft speed, approximately 105 feet per second.

Figure 10.b. Second exhaust flame and spread of fuel mist; 2.0 seconds after initial impact. Aircraft speed, approximately 70 feet per second.

Figure 10.c. Third exhaust flame and spread of fuel mist; 2.2 seconds after initial impact. Aircraft speed, approximately 60 feet per second.

Figure 10.d. Ignition of fuel mist; 4.1 seconds after initial impact. Aircraft speed, approximately 10 feet per second.

Figure 10
Ignition of Fuel Mist by Exhaust Flames from Exhaust Outlet

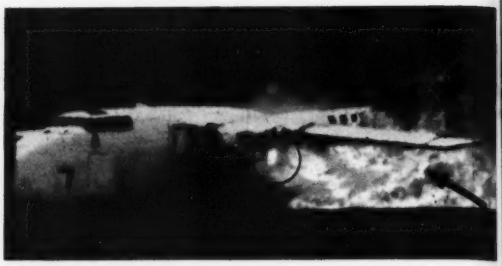


Figure 11. Largest exhaust flame from engine exhaust (circled) observed during the crash tests; 3.3 seconds after initial impact. Arrow shows fire caused by previous exhaust flame.

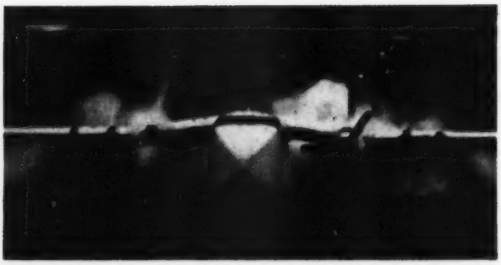


Figure 12.a. Deformation of right engine nacelle 2.2 seconds after initial impact. Aircraft speed, 60 feet per second.

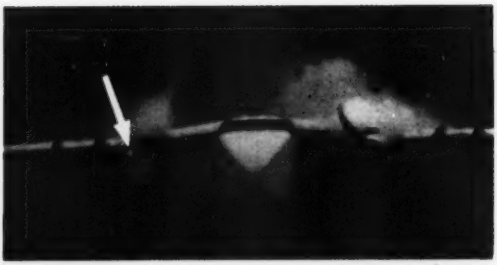


Figure 12.b. First indication of fire on right nacelle, 3.8 seconds after initial impact. Aircraft speed, 15 feet per second.

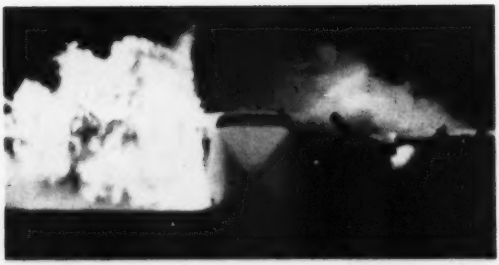


Figure 12.c. Fire development seconds after initial impact; 0.3 second after ignition. Airplane speed feet per second.

Figure 12
Mechanism of Ignition by Hot Metal of Exhaust Collector Ring

Figure 13.a. Ignition at left nacelle, seconds after initial impact. Aircraft speed approximately 98 feet per second.

Figure 13.b. Ignition at right nacelle, seconds after initial impact. Aircraft speed 50 feet per second.

Figure 13.c. Ignition at left nacelle another test, 1.9 seconds after initial impact. Aircraft speed 74 feet per second.

Figure 13
Low Volatility Fuel
Ignited by Exhaust Flame

Figure 14. Explosion of wing following ignition of gasoline flowing through anti-icing duct; 13 seconds after initial impact, 0.6 second after ignition.

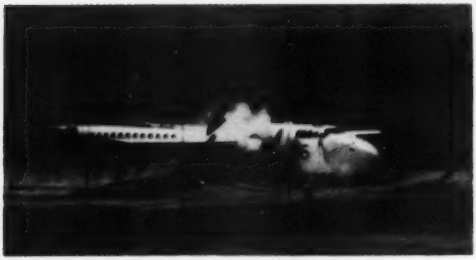


Figure 15.a. Impact of poles w landing lights (arrow), 0.25 sec after initial impact. Aircraft spe 143 feet per second.

Figure 15.b. Ignition on right si of aircraft (arrow), 0.60 second af impact. Aircraft speed, 135 feet p second.

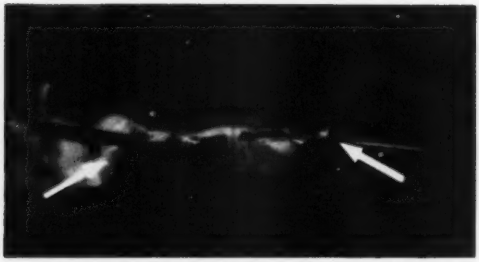


Figure 15.c. Simultaneous ignition o both sides of aircraft (arrows), 0. second after initial impact. Aircra speed, 135 feet per second.

Figure 15.d. Rapid development o fire, 1.8 seconds after initial impac Aircraft speed, 96 feet per second.

Figure 15
Ignition of Fuel by Landing Lights

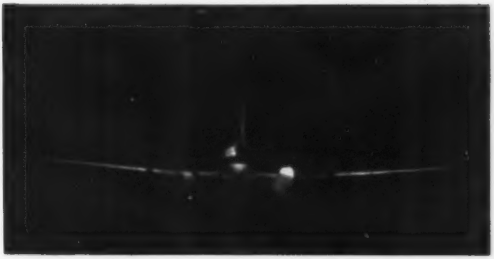


Figure 16.a. Ignition of induction system vapor-air mixture; 0.13 second after initial impact. Aircraft speed, feet per second.

Figure 16.b. Ignition of engine fuel from broken main fuel line in nacelle; 0.29 second after initial impact. Aircraft speed, 111 feet per second.

Figure 16.c. Ignition of fuel mist from fuel tank spillage; 0.71 second after initial impact. Aircraft speed 102 feet per second.

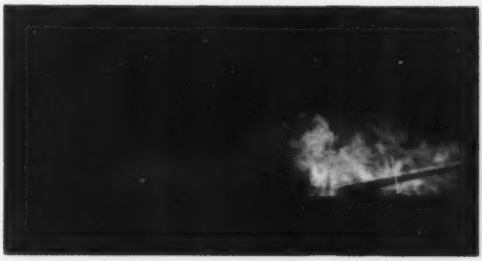
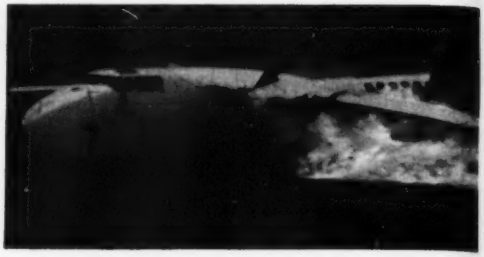


Figure 16.d. Spread of fire in fuel mist; 1.2 seconds after initial impact. Aircraft speed, 89 feet per second.

Figure 16
Spread of Fire from Ignition of Vapor-Air Mixture in Induction System

Figure 17. Induction system fuel ignition, 3.5 seconds after initial impact. Aircraft speed, 50 feet per second.



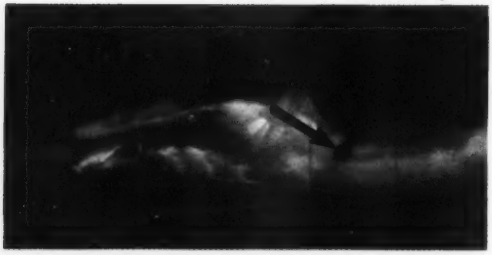


Figure 18.a. Wheel strut in air b fore ignition, 1.2 seconds after i tial impact. Aircraft speed, 75 fe per second.

Figure 18.b. Ignition of fuel mi 2.4 seconds after initial impact. A craft speed, 24 feet per second.

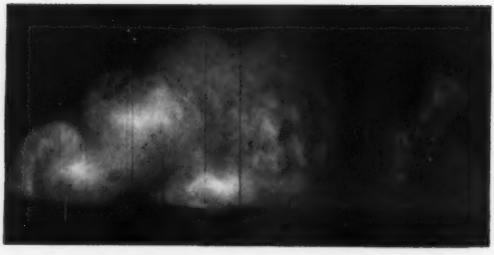


Figure 18.c. Spread of fire 3.9 se onds after initial impact. Aircra speed, 0.

Figure 18
Static Spark Ignition of Fuel Mist by Landing Gear

Indirect Fire Losses In Business

By James Joseph Crowley*

At one o'clock on a freezing November morning in 1952, a fire was discovered in the heart of the industrial district of a small New England town. Because discovery of the fire was delayed, 150 firemen, using 14 pieces of apparatus, took six hours to bring the blaze under control. It was another thirty hours before the flames were completely extinguished.

Four manufacturing concerns and three warehouses were wiped out. The direct fire loss reported by the NFPA as a result of this blaze was $275,000. The indirect losses sustained by the four industrial tenants are separately analyzed in this report, using facts accumulated as the result of a personal investigation. The true names of the concerns involved are not given, but the balance of the analysis accurately reports the significant aftereffects of this fire.

The Dexter Egg Company

The Dexter Egg Company, a branch of a large eastern dairy products distributing company, is in the business of buying eggs from local farmers, sorting, candling, crating and shipping them to the major markets. Of the four plants hit, this one recovered quickest. The day after the fire, they were relocated and ready for production. No customers were lost because other branches of the firm filled intermediate orders. There were, however, some very costly indirect losses. The company was forced to move into temporary quarters the next day. The rent increased by $140.00 per month, a jump of 87.5 per cent over the old rent. As a result of the fire and the higher rent, the company is now planning to build its own plant.

This new plant promises to be far superior for their purposes than their original quarters. However, it is expected to cost $40,000 and another $15,000 will be necessary for furniture, fixtures, insulation, painting and wiring. There is no doubt that with this new plant, the company operations will be more efficient and the employees will find it a more pleasant place to work. Nevertheless, this does not alter the fact that these indirect losses, the cost of temporary quarters and the new building, added to a direct loss of $20,000, because of under-insurance on stock and equipment, make this fire very costly to the Dexter Egg Company.

The Abbott Plastics Corp.

One of the more seriously affected plants is the Abbott Plastics Corporation. This company manufactured a line of products that included plastic plugs, wires and fishing boxes.

History Included Previous Fire

Before discussing the effects of this 1952 New England fire on the Corporation, it is interesting to review the past

*Mr. Crowley prepared a thesis under this title in partial fulfillment of the requirements for a degree of Bachelor of Science at the Massachusetts Institute of Technology. This is an edited extract of the complete thesis published by special permission of the Thesis Supervisor for the School of Industrial Management. The topic was suggested by Mr. Percy Bugbee, General Manager of the NFPA, and the Association Staff aided Mr. Crowley in the selection of material for this case study. The editors believe it is a unique and valuable contribution to a neglected aspect of fire waste.

Wide World

This is the property in a small New England town which housed the four business concerns whose indirect fire losses are discussed in this article. Despite the obvious huge physical destruction, indirect losses were even greater.

history of this firm when it was located in New York. At that time, only a few years ago, Abbott's main product was plastic cosmetic cases. It was a small, steadily growing company. Sales had climbed to about $100,000. Because of their limited line, however, production was seasonal. In an attempt to reduce the seasonal fluctuations, Abbott entered into a new agreement with another firm, the Delta Cosmetic Company, with whom they were already doing a limited business. Delta guaranteed orders averaging $12,000 per month on the condition that the Corporation embark on an expansion program. It was estimated that $45,000 would be necessary for additional space and equipment. At the time, however, the net worth of Abbott Plastics was only $50,000. Bank loans were not available because it was felt that the company was too great a risk for this amount of money. Finally, Abbott got an option on an R. F. C. loan of $25,000. Approximately $10,000 more was needed to start the expansion program and negotiations were advanced with private sources for the balance of the needed funds. Definite plans for expansion were being formulated. Then, disaster, in the form of fire, struck. The direct losses were large, but the indirect losses were even more.

The company had to find a new location since their plant, which they owned, was almost totally destroyed. A great deal of new equipment had to be purchased at a time when it was still difficult to buy. All Abbott's records, including inventory records, were completely de-

stroyed. The company had to hire a bookkeeper, an accountant, a regular employee, and an adjustor (fire specialist) to find out what had been in the plant before the fire. This task of merely finding out what was destroyed cost $3,700.

The Abbott Company suffered a very substantial loss in partially finished goods. It seems that under a current Delta contract, an order, worth $28,000, contained several different parts and was being held up by molding difficulties on one part. This bottle-neck had finally been eliminated. The company had the Delta order one-third to one-half completed, but not delivered. This was a total loss.

The Abbott Company suffered a dual blow with regard to the Delta Company. It not only lost this particular $28,000 order, but it also lost the Delta Cosmetic Company's goodwill. The fire occurred in August, in the middle of Delta's Christmas rush. They were furious about this disruption in their schedule because they feared that it was too late to give the order to another company. Delta was so upset, they have since never given Abbott another order. This was a very severe blow to Abbott because in the past, Delta orders represented about 40 per cent of their total sales, and under the expansion plans, Delta orders were to amount to at least $144,000, or an increase of 44 per cent over their entire former yearly orders. It is very difficult to lose such a customer and still survive.

The Abbott Corporation suffered another indirect loss as a result of this fire. Abbott had delivered an order to a pen and pencil company, but it was returned as the purchaser was not ready for the supplies at that time. The invoices had already been made out, and both parties agreed that the order was the property of the pen company. After the fire, however, that company refused to pay. Abbott had a legal and ethical right to collect, but proving this would probably be difficult and costly. Therefore, by not pushing the case, Abbott lost $2,000.

Another loss which was very severe, but to which no dollar and cents value can be attached, was time. If the insurance payment had been received immediately, the company could have resumed operation with very little delay. However, due to difficulties in adjusting the loss, the money was not received for six months and the company was necessarily idle all this time. When the money was received, the debts were paid off and the stock was retired.

Mr. Lawson, the only stockholder active in the business, was given the company as payment for six months' back salary and his stock. By this time, all that was left of the company was its name and its goodwill — even though the value of the latter was at low ebb.

The Abbott Company started back in business by sub-letting contracts. The way back was long and difficult. Sales were down 55 per cent from previous years.

A few months after the resumption of operations, the owners heard that factory space which was suitable for plastics work was available in a New England town. They decided to move.

Second Fire Part of This Study

At their new location, the Abbott Company began to recover. They experienced some difficulty in financing because they had since secured some government work and a large inventory was needed. The financing difficulty was overcome when in September 1952 the company was granted an R. F. C. loan of $34,000.

Another difficulty, indirectly caused by the New York fire, was a material shortage. At this time, raw materials were being allocated on the basis of past use, and the time period on which the allocation was based was immediately after the New York fire. As a result of this, Abbott lost many old customers simply because the raw material supply was not sufficient.

When the restrictions were relaxed, the company really began to prosper. In the eight-month period between February and November 1952, sales reached the $140,000 mark. In fact, a night shift was added. But their second fire occurred the very first night that the new shift started!

The company was hit hard again. The fire occurred when the monthly inventory was at its peak. Because of this, the direct losses were from $10,000 to $12,000 greater than the insurance coverage. But this was a small loss compared to the numerous indirect losses.

As an immediate result of the fire, the company lost the profits on $5,000 worth of wire and $1,000 worth of other products which had been already inspected and ready for shipment. In this fire, the die losses were quite substantial. They originally cost $50,000. The company had changed their product line to the point where these dies were used for many orders. The day after the fire, a bulldozer was sent in to uncover and recover as many of the dies as possible. This cost the company $7,000 and another $2,000 to $3,000 was involved to clean and reclaim those that were still serviceable. These dies were not owned by the Abbott Company. Their customers owned them. The policy established was that if the customers had insurance on the dies, insurance funds could be used to replace them; if, however, there was no coverage, as was true for the majority of the dies, the Abbott Company would try to replace them. The cost would have to be considered "goodwill."

Destroyed by the fire, also, was $5,000 worth of material belonging to another customer. This had been covered by insurance, but the policy had lapsed. Three months after the fire, it was not known who would bear this loss.

Relocation was a problem. The temporary quarters into which they moved was only one-eighth their previous floor space. Yet, the rent for these new quarters was reduced only $40.00 per month. This meant a substantial loss because the available space had been reduced by seven-eighths, while the rent was reduced by only two-thirds.

There are other losses involved in the change of location. . Abbott had made many major improvements in the old location. These costs were indirect losses attributed to the fire. Just before the fire, also, $3,000 - $4,000 worth of equipment was brought into the plant and had not been insured. This was a total loss.

This fire, like their New York fire, caused Abbott to lose contracts. One of the largest silverplate manufacturers cancelled a contract worth $10,000. An emergency Signal Corps contract worth $6,000 was lost. With these orders, Abbott could have been back in business within two weeks. Without them, it took two full months before production could be resumed. Company officials estimate that the shut-down caused a loss of $50,000 in sales. For the first eight months of the year, the company had staged a very successful comeback and was making a modest profit. Then the fire

occurred. The profit that was building up was wiped out and the company could not avoid another losing year.

Why did it take so long to resume operations? With the cancellation of several good orders, the prospective income was not large enough for banks or creditors to risk lending money or extending credit. In addition, the company had very little to offer as collateral. All the equipment was listed with the R. F. C. as collateral for its loan.

The interest on the R. F. C. loan was an expense that had to be paid. These payments amounted to $210 per month. The company owed a total of $50,000, and the interest on this was mounting. True, this could be paid off with the insurance money, $87,000, when it was received, but three months after the fire, the insurance adjustment had not been completed.

Operating with only ten employees, whereas formerly they employed thirty-seven, the Abbott Company is in the process of overcoming these setbacks.

Summary of Abbott's Loss

In summary, the Abbott Corporation's two fires have produced the following indirect losses:

1. Loss of important customers.
2. Cancellation of contracts.
3. Loss of profits on finished goods.
4. Expensive recovery and replacement of dies.
5. Loss of low-overhead property and property betterments.
6. Two costly relocations of the company under emergency conditions.
7. Loss of sales potential during prolonged shutdown.
8. Reduction of trained personnel.
9. Loss of records and inventories.

Walsh Cord Company

The Walsh Cord Company, assemblers of cords and cables, was perhaps the least affected of the four plants. At the time of the blaze the company had $25,000 worth of new stock and $10,000 worth of finished goods in the plant. All of this, covered with only $5,000 worth of fire insurance, was completely destroyed.

All of the company records were destroyed. However, most of their dealings were with the Signal Corps, so copies of the government contracts were secured with little difficulty. Before the fire, Walsh had $15,000 worth of government contracts. Instead of cancelling the contracts, the government did everything possible to assist the company. They gave them time extensions, new contracts and renegotiated all of the old contracts. Three months after the fire, Walsh held $30,000 worth of government business. In addition, they had $10,000 worth of commercial contracts.

This is not to infer that the company was unscarred by indirect losses, because this is impossible. Walsh found new quarters and was in production two weeks after the fire. The rent, however, was 30 per cent greater; the floor space one-third the size of the old location. This resulted in a production decrease to one-third the former output.

The loss of profit due to the fire was estimated at $1,000. About $8,000 worth of contracts were cancelled. With the greatly reduced space and temporary slow-up of orders, all of the help was not needed but the full force was kept until after Christmas. This cost the company over $1,000. The only active partner in the firm drew no salary from the day of

the fire until after Christmas. The company, which had employed six women and was growing, now employs only two.

Vermont Poultry Co., Inc.
Exitor Poultry Company

The fourth plant involved was the Exitor Poultry Company. This company was in the business of buying live poultry from the farmers, killing, dressing and selling them to large meat packing companies, such as Swift, Armour, etc.

Because part of their space was only slightly damaged, the Exitor Company was back in business the day after the fire in the same location. However, one must not construe this to mean that they did not suffer very substantial indirect losses. While they went right back to work, they could not resume the same business. Because of damage to the building and equipment, the company must now content itself with being a live poultry jobber. That is, Exitor purchases live poultry from the farmers, and then resells it to other dressing plants in the area and to the live market centers. Thus, the fire has drastically altered the business and their customers.

The over-all volume has been reduced by more than two-thirds. The company now handles less than one-third the number of chickens, and does no processing. This in turn affects the sales, which are also down by more than two-thirds of their expected total. In addition, in November, in the midst of the Thanksgiving, Christmas and New Year rush, their busiest season, their stock was wiped out.

Before the fire, this business operated on a very narrow margin. A slight fluctuation in price could mean a substantial loss. The average annual profit was only one per cent of the sales. Therefore, under the present arrangement, there is very little chance of making a profit. In fact, Exitor is now actually operating at a loss. The only reason that the company is still running is that the owner wants to keep a nucleus of his labor force intact and stay in contact with his poultry suppliers in the event that he should decide to resume the original business.

There are several reasons why the owner of Exitor is hesitating about returning to his old business. (1) He has lost contact with his customers. It is questionable whether he could regain a sufficient number of his large-order customers to make the reentry profitable. (2) At the present time, the business is being carried on in the old plant. To reestablish the old business, a new location would be required. Because of the odor involved, the new location would undoubtedly be best in a sparsely populated district. This means that a new building would probably be necessary. (3) Because the present equipment is old and outmoded, new equipment will be a prerequisite for success. This will require a large financial outlay. (4) The owner does not want to build a new plant until he is absolutely certain that the government regulations covering buildings used for this type of business can be met. Some of the larger meat packing companies will not deal with a firm whose plant does not meet these requirements.

There are several other indirect losses which have also caused a drain on the company treasury. The salvage value of the equipment was set at $14,000 by the insurance adjustors, but estimates, based on prices received for some equipment already sold, indicate that Exitor will be fortunate to receive $7,500 for this equipment. This represents a probable loss of $6,500. The lost profit on the poultry

destroyed by the fire was estimated to be $1,200. Since the company is not making a profit, it is losing the interest on the capital investment which would accrue if the money were invested elsewhere. In this case, it means the loss of interest on $52,000.

There are several fixed charges that will continue until the owner decides whether or not he is to remain in business. He is paying salaries amounting to $600 per week and insurance, depreciation, taxes, etc. equal to another $400 per month. The $600 per week is for the salaries of the five men retained.

It is quite obvious that a firm with lesser financial backing would be out of business. In fact, it is questionable how long this firm can continue to operate.

The Exitor Company has: (1) changed the character of its business; (2) changed its customers and lost contact with old customers; (3) lost money on the sale of equipment; (4) had capacity and sales greatly reduced; (5) is operating at a loss; (6) lost profits on products destroyed; (7) needs a new building and equipment to reenter previous field; and (8) lost interest on its capital investments.

Loss To The Community

Let us turn to some of the indirect losses suffered by the Community.

As a result of this one fire involving four small firms, eighty people were temporarily thrown out of work. This means that less money was available for spending in the town.

Because of present conditions, these people will encounter little difficulty in finding other employment if their old jobs are eliminated as a result of this fire. It is questionable, however, if they will find work in which they can take full advantage of their skills or receive as much pay. The community may not suffer too seriously immediately because of the elimination of jobs by this fire. Five years from now, the story may be different. The unemployment may someday place a heavy burden on community welfare rolls. It is reported, also, that a shoe company had planned to locate in the town but as a result of the fire their plans were cancelled. The loss of this industry with its potential payroll of 200 is a direct and severe economic blow to the town, whose total population is under 5,000.

Summary of Case Histories

In summary, each of these four companies has suffered heavily through indirect losses. The Dexter Egg Company must spend a large sum of money for a new building. The Abbott Plastics Corporation has lost several very important customers as a result of fires, and has been severely strained financially. The Walsh Cord Company has had its capacity reduced two-thirds. The Exitor Poultry Company has been seriously injured in that it has been forced to change the nature of its business and is losing money as a result. The community has lost income and has failed to secure a new business enterprise.

The case histories examined in detail here concern small companies. This is unfortunate in that it may lead some to believe that only small companies suffer indirect losses. This is certainly not true. Every one of the indirect losses cited can apply to large as well as small businesses. In fact, in big companies, when the direct loss is large, the trend is for the indirect losses to be even larger.

International

Scene of second fire briefly analyzed in this study of indirect fire losses in business. This is an example of a non-industrial loss.

It should not be assumed either that only businesses in the industrial field suffer from indirect losses. A fire in any establishment will cause indirect losses. Take, for example, the case of the Towers Hotel. The hotel was gutted by an early morning fire which caused an estimated direct loss of $250,000. In addition all hotel employees lost their jobs. Walls left standing were razed so that space previously rented in the building for stores and offices disappeared and, therefore, the employees of the stores were without employment. The town could no longer collect taxes on either the hotel or the stores. These are only a few of the indirect losses which resulted from this non-industrial fire.

Review—Indirect Loss Problems

Loss of Life and Injuries

Each year some 12,000 people in the United States die as the result of fire. In addition to the deaths from fire, there are as many or more serious injuries.

Of course, all of these deaths and injuries do not occur in factories or business establishments, but enough do to make this a very serious business problem. Suppose a customer or an employee were killed or injured in a "business" fire. What might be some of the effects? If it were a retail outlet, the company might lose customers who felt that they were inadequately protected. If it were a factory, the loss of a key employee might upset production plans, lower employee morale, and cause the factory to be labeled "a dangerous place to work." If death or serious injury resulted, the company might feel a strong moral obligation to aid the families of the victims. These and many other possible consequences resulting from loss of life or injury could add heavily to a company's burden.

Loss of Current Sales

An unusually large number of factory fires occur during the peak seasons. A serious fire at this time may be very costly because production may be slowed down or even completely halted. As a result, sales are interrupted and income is cut off. Without "fresh" money flowing in, a company may be forced to borrow to pay off current liabilities. Consequently, the company may go deeper into debt. Thus, the loss of current sales may be sufficient to force a firm out of business if it is not financially strong.

Loss of Profit on Finished Goods

Under the free enterprise system, the ultimate goal of business is profit. Yet each year businesses lose thousands of dollars in profits on finished goods which are destroyed by fire before reaching the buying public. Since profit is the life blood of a business, a choking off of this profit for any length of time could cause liquidation.

Loss of Records

Records are one of the more intangible assets which a company possesses. It is almost impossible to place a dollar value on them. Nevertheless, their importance cannot be over-emphasized.

If the records of a firm were destroyed, it would be confronted with many serious problems. For example, accurate information concerning accounts receivable and payable might be very difficult and costly to gather. This would be particularly true if there were a large number of firms involved and each account were fairly small. Other records that would be difficult to replace include trade "secrets," product formulas, lists of special customers, etc.

That some companies do recognize the value of records is demonstrated by the efforts they expend in protecting them. Some companies have fire-resistive vaults or record containers in which vital records are stored. Other companies reproduce the vital data on microfilm and provide safe film storage.

As more companies come to recognize the intrinsic value of their records, and the cost and difficulty of replacing them, they will take action to insure their protection against fire destruction and severe damage by water.

Loss Through Inability to Resist Unjust Claims

After a fire, a company may be subject to what might best be classified as "unjust claims." As an example, let us suppose that a manufacturing firm completes an order and is ready to deliver it on the prescribed date. A few days before delivery, the purchaser calls requesting that the company hold the order for a few days. As a gesture of goodwill, the company stores the order. But, since the goods are sold, they are removed from the finished goods inventory record. After the original delivery date, the company and this order are destroyed by fire. The purchaser neither has the goods nor has he paid for them. Therefore, he disclaims any ownership. The order has already been removed from the inventory records, and, therefore, the insurance company refuses to pay. Legally, the purchaser is the owner, but the manufacturer must prove this. When the manufacturer considers the expense, the unwanted publicity, and the question of being able to prove that the purchase was made, he will probably forego an attempt to collect the bill. If the claim is large, or there are many similar small ones, the manufacturer may find it necessary to try to collect his claims.

Inability To Prove Insured Loss

Immediately after a fire, insurance adjustors are on the scene to make appraisal of the damage. Unless detailed production data are available, the adjustor may have a difficult task deciding how much of the debris represents finished products. The remains may be so badly damaged that he can only guess or take the word of the owner. He may or may not desire to do this.

Destruction of Irreplaceable Products

Ordinary fire insurance covers not only buildings and equipment, but also raw materials, semi-finished goods and finished products. Even though money is available to replace these products, the loss may be very serious.

For example, in October 1941, Fall River, Massachusetts was the scene of the largest single industrial loss in recorded history up to that time. The loss represented the destruction of one-tenth of the crude rubber supply in the United States. At that time, the material was urgently needed for war production. Replacement of such a large volume of rubber was virtually impossible because shortly after this fire, our major supply of crude rubber was cut off, and our synthetic rubber program was still under development.

This loss was estimated at $15,000,000; it is impossible, however, to place a figure on what this fire actually meant to our defense effort at that time.

Loss of Drawings, Dies, Jigs, Etc.

In addition to buildings and raw material, fire may destroy many of the less obvious items which are essential for production.

In the engineering department, drawings and engineering data may be destroyed. Months could be lost reconstructing this information.

In the production department, patterns, special machinery and jigs could be ruined. Insurance coverage might pay for them, but valuable time would be lost waiting for replacement.

In the tool and die department, dies might be rendered useless. This could prove to be very serious because in many cases dies belong to customers rather than the company using them. Insurance may or may not include this equipment.

Building Income Loss

Damage to a building injures two groups — tenants and owners. In a particular case, the tenant and the owner may be the same.

Aside from the actual interruption of business, how does a fire affect tenants? If the fire is serious enough, the tenant may be forced to seek new quarters. In addition, he must bear the cost of preparing the new quarters and moving equipment. If the tenant decides to build his own plant, he will encounter the costs of temporary quarters as well as the construction costs.

On the other hand, the owner is adversely affected because he loses his building, his tenants and a steady income. Moreover, with today's building costs, he probably will be unable to build a comparable size plant with any insurance money he may receive.

Jeopardy to Property of Others

While on the subject of property damage, who is responsible if a fire starts on your property and spreads to adjoining property? As surprising as this answer may be, you may have to pay damages to your neighbor. Let us look at a few cases which demonstrate this fact.

A fire started in the grease vent of a restaurant and spread through the entire building, causing $200,000 damage. The grease vent, installed before the present owners had acquired the business, was found to lack metal sheathing which was required by law. A deputy fire marshal had inspected and approved the premises without noticing the violation. Yet, a court ruled that no notice from the fire marshal was necessary to inform the owners that the flue was inadequate, and the owners were held liable.

The owner of an unoccupied building allowed it to become littered with rubbish. Fire started and damaged adjoining property. The court held that the owner of the building was liable for negligently maintaining it so that a fire once started could spread.

In still another case, a company paid $40,000 damages, because a jury ruled that the company had stored goods in a way that hindered firemen in fighting the blaze which started on the premises and destroyed the building.

With courts taking this attitude, fire prevention becomes extremely important. It is now possible to use all of the insurance money you receive for your damage in paying the damages suffered by others because of "your" fire.

Continuance of Fixed Charges

After a serious fire, it may be necessary to suspend operations temporarily. This can be very expensive because of the burden of fixed charges that continue. In a business sense, the money paid out for these fixed charges must be considered a total loss because there is no return on the investment. What are some of these fixed charges? Salaries to key executives and employees must be continued to keep a nucleus of the internal organization intact. If the company employs anyone on a contract basis, this contract must be honored. Salesmen, in most cases, depend on commissions for the bulk of their income. If the company cannot deliver, the salesman naturally cannot take orders, and therefore, no commissions are forthcoming. To prevent the complete disintegration of the sales force, the salesmen — at least the key ones — must be put on a respectable drawing account. Turning to the capital actually invested in the firm, if this money is borrowed, interest payments must be paid regardless of whether or not income is being produced. If the invested capital is not borrowed, there is what might be termed a "hidden" loss. That is, the loss of interest that would accrue if the money were invested in some other enterprise.

Loss in Sale of Equipment

After a fire, there is the possibility that equipment is no longer useful to the firm. Damage may be too serious for the original purpose, but the equipment may still be valuable to other firms. On the other hand, the equipment may be in excellent condition but the firm may be going out of business. Regardless of the circumstances, the equipment has a certain salvage value which is estimated by insurance adjustors when they are assessing the insured loss. If a firm tries to sell this equipment at forced sale, it is very possible that it cannot receive a price close to the salvage value. Therefore, the difference between the salvage value and the sale price is a loss.

Seizure of Insurance Payments and Loss of Credit

Many firms are dealt a severe blow in their recovery program by the seizure of

insurance payments by banks or other creditors to satisfy obligations, leaving little for rebuilding. This is especially true if the creditors foresee the least possibility of a failure to recover. By their very acts of seizing the insurance money, creditors make recovery virtually impossible. It is probable that many companies with good products have been forced out of business by banks that did not want to invest capital in firms that were unfortunate enough or careless enough to be the victims of large fires. If banks are the least bit hesitant about investing, other companies with whom the firm was doing business may refuse to extend commercial credit.

Loss of Customers

When a company has to suspend operations temporarily, its customers must look elsewhere for products. When the company is ready to resume operation, there is a strong probability that it will not be able to recapture all of its old clients. There are two main reasons for this: (1) the customer may be receiving equal or superior service and equal or superior goods, and (2) the customer has a sense of loyalty to the new supplier who took care of him when his regular supply failed. This argument is particularly strong if, at the time of the fire, there was any scarcity of the products or the new supplier went out of his way to aid the distressed customer.

A few years ago a mid-western shoe company burned just before the Easter season. Production was completely stopped and, as a result, the salesmen notified all customers that Easter orders were cancelled. With only a few weeks left, it was going to be difficult for the dealers to order shoes from other firms and receive them on time. Several competing shoe companies saw this difficulty and did everything possible to aid the stranded dealers. It is not difficult to guess the results. The fire-struck shoe company was completely rebuilt and remodeled, but, because the other firms had done everything possible to aid the shoe distributors, these distributors were reluctant to take business away from their benefactors. The final result was that the reconstructed shoe company went out of business.

Loss of Sales Force

A company depending heavily on its sales force faces another serious problem. If fire interrupts operations, competitors will be very anxious to deplete their rival's sales organization by hiring key salesmen and top sales executives.

Adequate salaries and expenses during shut-down will help keep a sales organization intact. However, sometimes this is not enough. Take the case of the sales executive who was receiving a salary of $50,000. Fire temporarily closed the business, but the salaries of this company were insured. During the shut-down period, he received his salary in full. But, what did the future hold? He knew his salary was actually based on the volume of sales. He also realized that it would be difficult to build sales to their pre-fire level. After this one-year, fire-insured salary, he would be expected to take a very large reduction. Therefore, when a competitor offered him the same salary, he accepted and many of his customers also shifted.

Loss of Cumulative Value of Advertising

A production-stopping fire can ruin the cumulative value of advertising

that has been carefully planned and built up over several weeks or even months. For simplicity's sake, let us assume that a firm is going to release a new type fountain pen on a specific day. For the last month an advertising campaign has been stressing that something different in pens will be displayed on this particular day. About a week before the distributors receive their supply, the factory and the entire stock are destroyed. What is all the advertising worth? By the time the company is again ready, all this past advertising will be forgotten and a new campaign will be necessary.

Summary

It is almost impossible to make any sort of estimate monetarily as to the cost of indirect losses. A major reason for this is the intangible nature of many of the losses. A figure simply cannot be placed on them. In addition, many indirect losses have a delayed action. Their full impact may not be felt for several months after a fire.

However, each indirect loss can be a severe blow to a business; cumulatively, they can even add up to business failure. From studies conducted, it is certainly evident that each year hundreds of firms are wiped out of existence by fire.

Cooperation In Denver

The relations between Building Departments and Fire Departments in the average U. S. city or county are often strained because of overlapping responsibilities and, sometimes, conflicting conceptions of proper safeguards in the public's interest. This subject was discussed in an article entitled "Building Codes and Fire Prevention Codes" in the *Quarterly* for October 1935 and in the April 1945 issue there was a report on "Fire and Building Department Co-ordination" in Detroit.* These texts stress the importance of cooperation. From Denver, we now have a report on the cooperation in effect there.

The 1935 *Quarterly* article, written by Messrs. Bugbee and Bond concluded:

"If building codes and fire prevention codes are properly drawn and proper definitions of the functions of the building department and the fire prevention bureau of the fire department are incorporated in such codes, and if the two departments cooperate with a mutual understanding of each other's problems, harmonious and efficient control of the fire hazards may be secured in any city, and better construction and protection with consequent reduction of hazards to life and property will be secured."

The City of Denver operates under its own revision of the 1949 Uniform Building Code of the Pacific Coast Building Officials Conference. The Building Department of the City and County of Denver is under the capable management of George R. McCormack who took office three years ago. The fact that Mr. McCormack's father, Captain James F. McCormack, was the first head of the Fire Prevention Bureau of the Denver Fire Department, hasn't exactly hurt his present relationship with Assistant Chief Murry Wolz, now Chief of that Bureau, who, also, has been a close friend of Mr. McCormack since high school days. Fire Chief Allie A. Feldman has officially effected and abetted the coordination.

*Available in pamphlet form for 10c a copy.

The Building Inspection Department for the City and County operates with only 45 inspectors for a population of approximately 435,000. It is obvious that this number of inspectors could not hope to control the construction, use and occupancy of 163,500 buildings. Since the Fire Department, having some 500 men, are constantly inspecting existing buildings, Mr. McCormack and Chief Wolz have found it mutually beneficial to train each other's personnel in the fundamentals of their respective responsibilities.

How Cooperation Works

Thus, in all routine Fire Department inspections, the general condition of the building is noted as well as specific fire hazards. If, for instance, open stairwells are found in a building exceeding two stories in height or if there is insufficient means of egress in a building which has been converted from residential to apartment or hotel occupancy, the inspecting fire fighter sends a complaint form to the Building Department. In each instance upon receipt of such a complaint, an inspector from the Building Department checks the building and makes out a formal order for the correction of all things that are necessary to put the building in substantial compliance with the Code.

While the responsibility of correction was formerly shared jointly by the Fire Department and the Building Department, the delineation of such responsibility was not definite enough to assure the needed action. Now the responsibility of detection lies largely upon the Fire Department and the work of correction has been reserved to the Building Department, except, of course, for such exclusively fire department responsibilities as accumulations of trash, rubbish and combustibles or the storage and dispensing of flammable liquids and gases.

Summary

Chief Inspector McCormack observes that "it has been our experience that firemen in their inspection and enforcement duties are often inclined to be ultraconservative on the side of fire safety. Building officials, on the other hand, are frequently inclined to be superconscious of the building structure itself and negligent about fire protective features which are the heart of any building code." With the present working arrangement, a proper balance is achieved and the public benefits.

The four fundamentals justifying a building department, as outlined by Bert Wood of the American Iron and Steel Institute,* are the guiding principles of the Denver operations. These fundamentals are:

1. To provide for the *safety of occupants* of buildings and to make provision for their exit without loss of life during a fire.
2. To provide for the *safety of firemen* fighting fire.
3. To provide for the *safety of adjoining property* and to prevent the spread of fire.
4. To provide for the preservation of the property itself.

It is a matter of fundamental policy in Denver that both building and mechanical inspectors of the Building Department report to and assist at all major alarm fires and that all operations of the Department are coordinated with the Fire Prevention Bureau.

Denver proves it can be done — well.

*See "Fire Protection Through Modern Building Codes" (1950 Edition), by B. L. Wood available from the American Iron and Steel Institute, 350 5th Avenue, New York 1, N. Y. ($2.00 per copy).

Blast Rips Cleveland Streets

By Clark F. Jones, NFPA Gases Field Engineer

Cleveland's West Side was shaken by a severe underground blast in a city trunk sewer under West 117th Street on Thursday, Sept. 10, 1953, about 5:20 P. M. One woman was killed and 64 persons injured. In addition to destruction to streets, sidewalks and utilities, at least a score of vehicles were damaged. Loss was estimated at $5,000,000.

The explosion occurred in a combination sanitary and storm sewer under West 117th Street. This street is the dividing line between Cleveland and Lakewood. The blast demolished the sewer line from Berea Road to a point 100 feet beyond the intersection of Clifton Road, a total distance of approximately 1.2 miles.

Sewer Construction

This sewer was mainly of circular brick construction, about 7 feet in diameter, installed 8 to 10 feet below street grade. However, where the sewer ran under a sidewalk (see photo next page), it was of reinforced concrete construction and was approximately 6 feet by 6 feet in size. Sewer grade in this portion of the line was above street grade due to the fact that the street was depressed to go under a railroad overpass. Along this portion of the above-grade sewer, lack of adequate venting prevented release of any gaseous concentration which might develop in the sewer.

The section of the city in the vicinity of this sewer consists of mixed manufacturing, commercial and residential occupancies. The neighborhood included garages, filling stations, cleaning and dyeing establishments and other commercial occupancies.

Cleveland Fire Department

Section of West 117th Street depressed to run under railroad overpass. The sewer in this area was above street grade and constructed of reinforced concrete.

Cleveland Fire Department

How the reinforced section of sewer was disrupted by the mysterious blast on Sept. 10, 1953 on West 117th Street in Cleveland.

Extent of Damage

The incident occurred during the peak of the evening rush hour exposing surface vehicular traffic and pedestrians to the shattering of the street paving which was upheaved or broken as a result of the shock wave. Some automobiles were crushed under chunks of concrete and paving. Manhole covers were sent flying through the air. Several cast iron water mains broke and flooded the area. Water Department emergency crews responded and closed the valves in the affected area. Several city gas mains of the East Ohio Gas Company were broken as a result of the blast. These lines were properly capped by the utility company's employees shortly after their disruption. Some underground electric and communication cables were severed, but no fire developed. One automobile which was hit by debris developed a short circuit in the wiring. The small fire which resulted was promptly extinguished by a hand extinguisher from a Cleveland Transit System bus.

Fire Department Response

Approximately 26 pieces of equipment from the Cleveland and Lakewood Fire Departments, including auxiliary units, were dispatched to the scene of the disaster by Chief Elmer A. Kane of Cleve-

Cleveland Fire Department

The center of the street collapsed where the sewer ran under the streetcar tracks.

land and Chief C. A. Delaney of Lakewood. Fire Companies responding engaged in rescue work, flushed sewers and cleared away automobiles. Hundreds of Cleveland and Lakewood police and firemen, including C.D. auxiliary units, were dispatched to aid in the rescue work, rerouting traffic and helping to avert panic.

A secondary minor blast occurred at approximately 6:25 P. M. in the vicinity of Clifton Road and West 104th Street, about ¼ mile from the West 117th blast. This second explosion blew manhole covers into the air but caused little damage.

Area Old Gas Well District

An interesting sidelight on this incident is that prior to 1913, when the district was mainly farm land, a very large number of both deep commercial and shallow residential gas wells were drilled in this area during the time the state had no control over such drilling. Apparently a large number of these wells have not been properly capped and others are still producing. Within recent years several wells in the locale have been known to have caused trouble. In a preliminary survey during the recent investigation several of the shallow wells were test probed and found to be leaking.

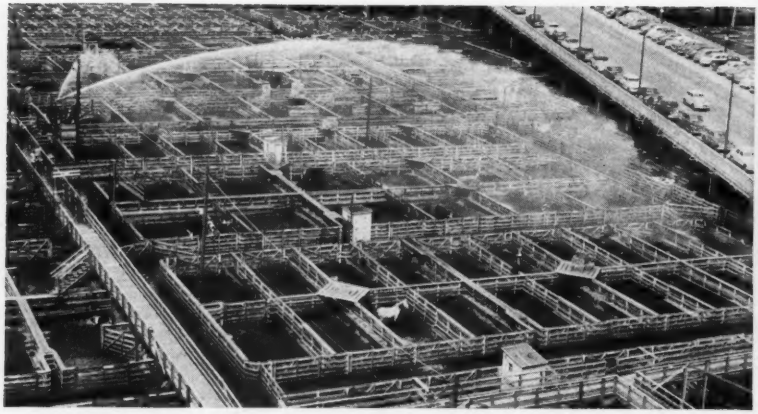
Indicative of neighborhood conditions is the existence of an active well in the boiler room of a church where the oil seepage was piped into the outside underground fuel oil storage tank and then vented to the atmosphere. Economically this may have been good practice, but from a safety and fire viewpoint this was a very hazardous procedure. Upon discovery of this condition the city Fire Prevention Bureau immediately corrected this malpractice.

Cause Actually Undetermined

The cause of this explosion has yet to be determined. A number of investigations are under way. A committee directed by Dr. Samuel Gerber, County Coroner, is conducting the official investigation. Countless stories, reports and surveys are being investigated. A report from this committee is not anticipated for some time. Numerous theories as to what caused the explosion have been advanced by various authorities and those getting the most credence are:

1. Industrial waste might have been discharged accidentally or intentionally into the sewer from one of the commercial plants in the neighborhood.
2. An accidental or intentional spill of flammable liquid emptied into the sewer.
3. Seepage from abandoned natural gas wells in the area leaked into the sewer.
4. Accumulation of sewer gas.

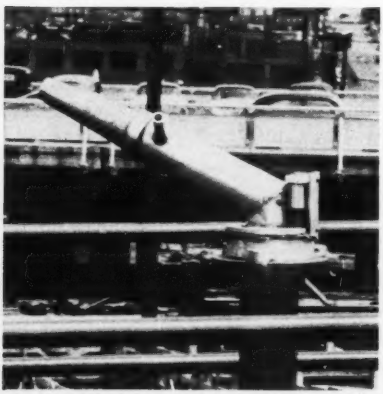
At the present time no conclusions have been reached. All efforts are being directed towards corrective recommendations which will tend to prevent future explosions. Considerable thought is being given to how the new sewer, when constructed, will be provided with adequate ventilation.



Omaha Stockyards Fire Monitors

By T. R. Smith, Assistant Chief Inspector
Omaha Fire Department, Bureau of Fire Prevention

About four years ago the Union Stock Yards Company of Omaha (Ltd.) started experimenting with a fire monitor type nozzle different from any which had ever been designed for stockyard fire prevention and protection. After trying out the nozzle in all kinds of weather and under adverse operating conditions, 27 of these nozzles were installed on steel towers at strategic locations throughout the sprawling yards. The system supplements the previously designed fire protection available and will be used principally for containment of a fire while regular hydrant hose streams are employed for actual fire extinguishment. The monitor sprays are also very useful to lay dust and wet down "tinder-dry" areas in extremely dry weather or drought periods.

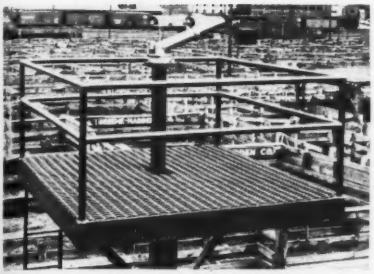


Omaha Fire Dept.

Photo No. 1. Aluminum monitor nozzle with 1 ¼ in. orifice. Note impulse jet to effect rotation.

Monitor Nozzle Design and Position

The monitor nozzles are constructed of aluminum and have an internal diameter of 1¼ inches (see Photo No. 1). The speed of monitor revolution is adjustable and governed by an hydraulic mechanism. Rotation is caused by a small impulse jet at one side of the barrel, clearly shown in Photo No. 1. Deflectors built inside the barrel cause the water stream to be broken down into a fine spray throwing a continuous "sheet" of water from the base of the nozzle to the end of the stream.



Omaha Fire Dept.

Photo No. 2. Tower platform is 14 feet above the ground. Expanded metal grating keeps snow and ice from accumulating.

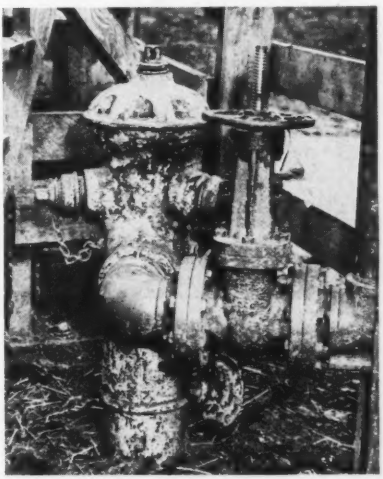
The nozzles are mounted on the top of steel towers (see Photo No. 2) with the base of each nozzle 14 feet above the ground. The nozzles are fastened at the base to the 4-inch pumper connection of a hydrant (see Photo No. 3). A valve is placed between the hydrant and the nozzle but is sealed open. The seal must be broken before the hydrant can be used in the conventional manner. The connection was made to the hydrant's pumper outlet since it is impossible to actually line up a fire department pumper in the Stock Yards in such a position to utilize this connection for its designed purpose. This still leaves two hose connections on each hydrant and, since the towers are normally located at every other hydrant, the monitors do not interfere with using the hydrants for conventional purposes. A flanged valve at the hydrant permits removing the hydrant for repairs without disturbing the tower.

Operation of Monitors

To operate the fire monitor, it is only necessary to turn on the fire hydrant. The nozzles at Omaha are set for one rotation every two-and-one-half minutes. This method of operation leaves the nozzle and all connecting lines to the hydrant dry when not being operated since the drainage system for the hydrant is utilized in keeping the nozzle and connecting lines drained.

Construction of Towers

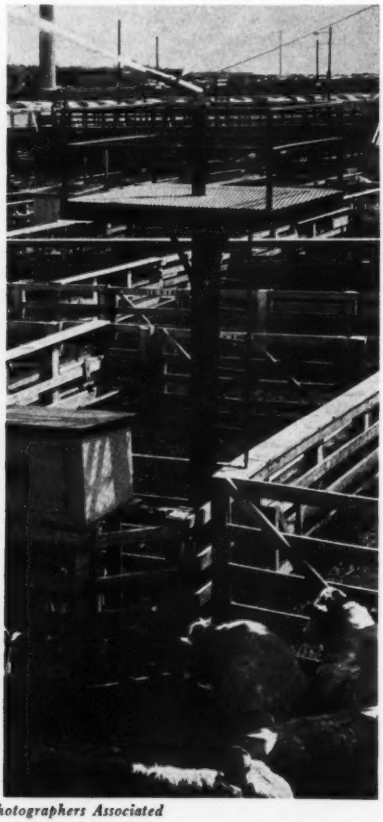
The towers are built of steel and have an expanded metal grating on the floor to keep snow and ice from accumulating and making it slippery. A ladder is provided from the top of adjacent pen fences and a railing surrounds the platform (see Photo 4). The "leg" of each tower consists of a single six inch "H" column set four feet in concrete. The four inch water riser is set inside the flange of the "H" column. The platform and tower were provided for stabilizing the water riser, for adjustment and maintenance of the nozzle and to allow the nozzle to be held in one position if so desired. The side thrust of the jet can



Omaha Fire Dept.

Photo No. 3. Riser to monitor nozzle connects to 4 in. pumper outlet leaving other 2½ in. outlets serviceable.

be easily overcome by a little pressure on the opposite side, allowing fire fighters to direct the monitor streams as desired. Each nozzle has a radius of 180 feet, an elevation of 14 feet and takes care of an area equivalent to a city block. Varied water pressures and different settings give different coverage. Faster rotation is not desirable since the centrifugal force would then cut down the effective radius covered by the stream.



Photographers Associated

Photo No. 4. Towers can be reached by ladder from top of pen rails. Riser is in flange of six-inch "H" column.

Advantages of Monitors

It is felt that this fire monitor system has considerable advantage over other types which throw a solid stream and require an operator at the nozzle. A solid stream of water tends to scatter the usual type of stockyard fire involving hay and lumber, starting other fires. These new nozzles installed at Omaha, on the other hand, lay down a curtain of water which extinguishes flying sparks and wets down the hay, bedding and fences where any embers might alight. Since these monitors are actuated at hydrants at ground level, they can be reached readily by fire fighters who can then take proper steps for extinguishing the fire with hand hose lines while being protected by the spray from the rotating monitors.

The construction of the new monitors has been under the supervision of the Engineering Department of the Union Stock Yards Co. A training program has been inaugurated by the company and other firms connected with the livestock industry at Omaha will be taught the proper operation and utilization of the new fire monitor system, together with a review of the other fire-fighting and alarm systems which the monitors supplement.

Record Container Performance

A Study By NFPA Fire Record Department

The National Fire Protection Association has prepared the following analysis of record container* performance based on reports of 394 fires occurring from 1947 to 1952 inclusive and involving 639 record containers. The performance of 53 vaults was also analyzed and reported.

Certain records are necessary to continued operation of a company. Inventories, accounts receivable, original drawings and contracts are some of the vital records which, if destroyed by fire, could mean interruption or even discontinuance of a business. In either case their destruction would represent a sizable part of the total dollar loss caused by the fire.

Recognizing the need for a guide for record protection the NFPA, in 1923, organized its Committee on Protection of Records. The most recent publication by this Committee, published in 1947 and called *Protection of Records*† is a consolidation of reports on various phases of the subject presented by the Committee during the years 1942-1946. It shows the importance of records to the continuance of a business and helps the owners and custodians of records to understand better how to estimate and provide the protection needed.

The factual evidence set forth in the following survey substantiates the judgment of the Committee that containers are now available that will provide protection for records under all degrees of expected fire exposure, intensity and duration. Once the maximum expected exposure has been determined from a knowledge of the hazards inherent in the building construction and occupancy, one can readily select a labeled* record container that will provide the necessary exposure protection.

Method of Analysis

The 639 record containers analyzed in this survey include 345 containers that had been tested and labeled by a recognized testing laboratory and 294 that could not be identified as labeled units. In order to study the performance of containers of different ratings under various periods of fire exposure, the containers have been grouped into four classes, namely: 1-hour, 2-hour, 4-hour and unlabeled.

As pointed out in *Protection of Records,* building occupancy and building construction each influence the degree of fire exposure to which a container will be subjected. In an effort to show the effect of building occupancy on container performance, the four classes of containers were further subdivided into seven broad occupancies in which the fires occurred. These are: manufacturing, mercantile, offices, places of assembly, storage, residential and miscellaneous.

*Record containers include safes, insulated record containers, insulated filing devices and insulated cabinets.

†Pamphlet No. 232, 64 pages, published by the NFPA. Price $1.00 per copy.

*Tested and labeled by a nationally recognized testing laboratory such as Underwriters' Laboratories, Inc. The label gives the rating of the container. Containers are rated under standard fire conditions, measured in the time interval before the interior of the container reaches 350° F, which provides a factor of safety, since the ignition temperature of most paper is somewhat higher.

Pat Mitchell

The $2,500,000 property damage caused by fire at the State Office Building, Lansing, Michigan, Feb. 8, 1951, was minor in comparison to direct and indirect losses of records, plans, etc. An estimated 1,000 to 1,500 tons of records were destroyed.

Michigan State Police

Records in the substandard filing cabinets shown here were part of the 1,000 to 1,500 tons of records destroyed in the Michigan State Office Building fire.

Determination of the effect of building construction (fire-resistive or not fire-resistive) could not be undertaken since all of the fires in this analysis occurred in other than fire-resistive buildings.

Labeled vs. Unlabeled Containers

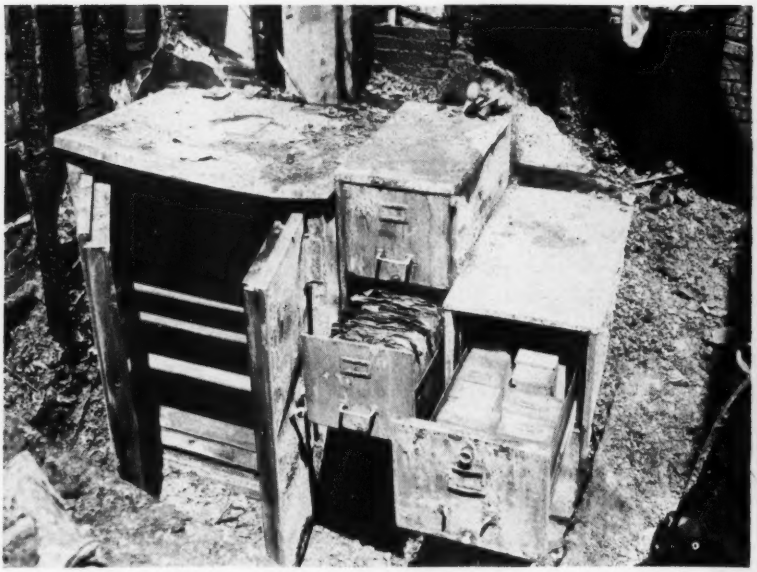
Table No. 1 shows that although 219 of the 345 *labeled* containers (64 per cent) were damaged, the contents of only 40, or 12 per cent, were affected. Of the 40 labeled containers whose contents were damaged or destroyed, in eight cases, safe doors were left open and in two cases safe doors opened when containers fell. The contents of 19 (6 per cent of the total) were subjected to fire and heat in excess of the labeled rating, based on the judgment of those reporting the circumstances of each case studied. Ten containers were submerged in water and careless use of an acetylene torch was responsible for one loss. Eighty-one per cent of *damaged labeled containers* came through with contents preserved.

Table No. 1
Container Performance—All Occupancies

	Labeled Containers				Unlabeled
	1-hour	2-hour	4-hour	Totals	Totals
Condition of Container					
Normal After Fire	72	40	14	126	74
Abnormal† After Fire	143	54	22	219	220
Totals	215	94	36	345	294
Cause of Abnormal† Container Condition					
Fell	22	11	5	38	29
Struck	14	0	1	15	10
Exploded	0	0	0	0	6
Previous Damage	2	0	0	2	1
Exposure Judged Excessive*	83	29	5	117	105
Other	10	5	7	22	21
Unknown	12	9	4	25	48
Totals	143	54	22	219	220
Condition of Contents					
Preserved	186	84	35	305	178
Heat-Fire Damage	16	6	1	23	70
Smoke Damage	1	1	0	2	5
Water Damage	12	3	0	15	39
Unknown	0	0	0	0	2
Totals	215	94	36	345	294
Cause of Destruction of Contents					
Door Open	7	2	1	10	8
Exposure Judged Excessive*	14	5	0	19	36
Not Insulated	0	0	0	0	4
Obsolete Design or Construction	0	0	0	0	51
Under Water	7	3	0	10	16
Other	1	0	0	1	1
Totals	29	10	1	40	116

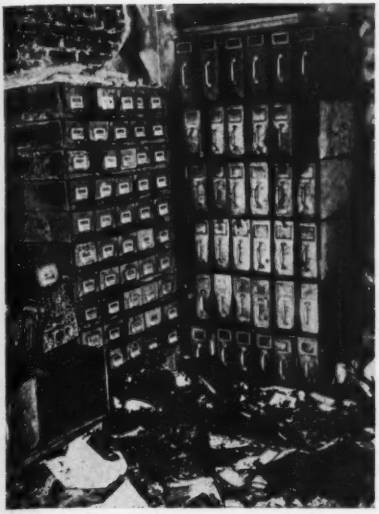
†The condition of a container was classified abnormal if, in the judgment of the inspector, the container was so damaged that it could no longer be safely used to protect records.

*For labeled containers, "exposure judged excessive" means exposure in excess of the labeled rating based on the judgment of the reporting agencies (see footnote Table 2). For unlabeled containers, inspection indicated exposure was excessive for the construction.



The 2-hour safe at left and the 1-hour insulated file at right protected their contents during fire of several hours' duration that destroyed a furniture store at San Bernardino, Calif. The contents of the uninsulated filing cabinet in the center was severely damaged.

View of same containers as in upper picture, taken before debris was cleared.



Valuable genealogical records kept in these uninsulated files were destroyed in fire on Nov. 20, 1947 at Boston, Mass.

Of 294 *unlabeled* containers reported, the contents of 116, or 40 per cent, were damaged (compared with 12 per cent in the case of labeled containers). Eight doors were left open. Contents in 36 containers (12.5 per cent of the total) were exposed by heat and fire judged to be excessive for the type of construction of the container. Four containers were known to be non-insulated and 51 containers were considered obsolete because of outmoded design or construction. The contents of 16 containers were submerged in water and one safe exploded. Only 47 per cent of *damaged unlabeled containers* came through with contents preserved as against 81 per cent of labeled containers.

From the reports submitted, exposure in excess of the labeled rating* appears to be the largest single cause of *container* failure, confirmation of the importance of considering building occupancy and construction when selecting the proper containers. As can be determined from Table No. 2, however, 281 out of 310 labeled containers, or almost 91 per cent, were subjected to fires in excess of the labeled rating based on the judgment of those reporting, yet the contents of only 32, or less than 11 per cent, were damaged. As the container rating increases to two and four hours, the performance record in the case of excess exposure improves.

In studying the experience of the three classes of containers (1-hour, 2-hour and 4-hour) it was significant that the survival of contents in each class was between 86.5 per cent and 97.2 per cent.

Performance of Labeled Containers

One-hour containers

There were 215 1-hour containers analyzed in this study. Referring again to Table No. 1, it will be noted that although 143 (67 per cent) of the containers themselves were damaged, the contents of only 29, or 13.5 per cent, were damaged or destroyed. There were two principal reasons for the large number of damaged containers: (1) 83 damaged by exposure judged in excess of the labeled rating (average length of fire was 4.6 hours), and (2) 36 damaged by collapsing floors, falling debris, etc. Miscellaneous reasons were responsible for damage to the remaining 24 1-hour containers.

In the analysis of damage to contents and the reasons therefor it is interesting to note that although exposure judged excessive damaged 83 1-hour containers, in only 14 cases was exposure sufficient to

*Under actual fire conditions several factors influence the degree of exposure to which a container has been subjected and therefore the duration of a fire in hours is not in itself a measure of the exposure to which a container itself has been subjected.

These two pictures show graphically the value of insulated containers for protection of records. These containers were in an unsprinklered 1-story brick and steel building occupied by a metalworker and destroyed by a 5-hour fire on October 1, 1948. The 1-hour insulated files at right and the 2-hour insulated safe at center protected their contents. Papers in the uninsulated files at left were destroyed.

Table No. 2*

Effect of Length of Fire on Container Performance

Labeled Containers

Container Label	Length of Fire†	Normal Containers	Abnormal** Containers	Contents Preserved	Contents Damaged
1-hour	Under 1 hour	3	3	6	0
	1-2 hours	10	11	20	1
	2-4 hours	17	38	43	12
	4-6 hours	18	30	47	1
	6-8 hours	9	25	31	3
	Over 8 hours	5	20	19	6
Totals		62	127	166	23
2-hour	Under 1 hour	1	0	1	0
	1-2 hours	3	4	5	2
	2-4 hours	9	14	19	4
	4-6 hours	7	11	17	1
	6-8 hours	9	8	17	0
	Over 8 hours	6	14	19	1
Totals		35	51	78	8
4-hour	Under 1 hour	0	0	0	0
	1-2 hours	1	2	3	0
	2-4 hours	3	9	11	1
	4-6 hours	6	4	10	0
	6-8 hours	2	1	3	0
	Over 8 hours	2	5	7	0
Totals		14	21	34	1

Unlabeled Containers

	Under 1 hour	2	2	3	1
	1-2 hours	9	18	19	8
	2-4 hours	18	65	51	32
	4-6 hours	20	38	39	19
	6-8 hours	15	34	35	14
	Over 8 hours	10	48	29	29
Totals		74	205	176	103

*Only 589 of the 639 containers were analyzed for this table since duration of exposure data were omitted from reports of fires involving 35 labeled and 15 unlabeled containers.

**See footnote Table 1 for explanation of "abnormal" containers.

†The duration in hours given below represents the time of container exposure to fire and heat based on the judgment of the reporting agencies. The time in hours is the estimated duration of fire of sufficient intensity to make for significant exposure to record containers. In most cases the data as to temperatures is meager or lacking and therefore these time figures do not necessarily have any correlation with the time ratings of record containers determined by tests where the temperatures are controlled in accordance with the NFPA-ASTM standard time-temperature curve.

destroy the contents. Open doors on containers, and containers submerged in water were other important factors responsible for damage to contents.

The statistics compiled on 1-hour container performance in Table No. 2 show that complete reliance can be placed on the container to protect its contents for at least one hour. In no instance of a fire of less than one hour's duration was the contents damaged. From the fact that the contents of only 23 of the 189 1-hour containers exposed for more than one hour suffered damage, one might be led to the conclusion that a 1-hour container will often offer many times its rated protection. Such a conclusion is dangerous since the duration of a fire is not an ac-

curate measure of its intensity. Important factors having a bearing on intensity of exposure, that the statistics in Table No. 2 do not take into consideration, include the amount of combustible contents in the fire area (controlled to some extent by the occupancy of the building), the degree of combustibility of the building (compare a steel-framed, metalclad building with a wooden building) and the effectiveness of fire protection (in one case a 1-hour container survived a six and one-half hour fire because it was kept cool with fire department hose stream).

TWO-HOUR CONTAINERS

There were reports of fires in which 94 2-hour containers were exposed (see Table No. 1). Damage was suffered by 54, or 57.4 per cent, whereas 143, or 66.5 per cent, of the 1-hour containers were damaged. Due to the greater fire resistance built into 2-hour containers, the better record of survival was to be expected. As in the case of 1-hour containers, exposure judged in excess of the labeled rating of the containers was the principal reason for damage (53.7 per cent) and damage due to collapsing floors, etc., was the second largest cause (20 per cent).

Although 54 of the 2-hour containers were damaged, the contents of only 10 were destroyed. In five instances excess exposure was judged responsible for the damage. Three containers were submerged in water and two container doors were left open. No 2-hour labeled container failed to live up to its rating because of any weakness in the container. In one of the two cases where damaged contents occurred in fires of less than two hours' duration, a container door had been left open, and in the other, the container fell into the basement and was submerged in water when the building collapsed.

FOUR-HOUR CONTAINERS

Reports of 36 4-hour containers were studied in this analysis. Of these, 61 per cent suffered damage to the container whereas the contents of 97 per cent were preserved. Collapsing floors and falling debris (six instances) and fire exposure judged in excess of the container rating (five instances) were the primary reasons for container damage. The one failure to protect contents occurred when the container fell causing its door to open.

Container Performance by Occupancy

In selecting the proper container for the protection of records under the most severe exposure conditions, many factors must be considered that affect the maximum intensity and duration of the fire. Among them are the character and concentration of combustible contents in the building. Since occupancy to a large degree determines the amount of combustible contents present, an effort was made to show the importance of considering occupancy when determining the proper container rating. There is little of significance in the tabulation of container performance as shown in Table No. 3, but this lack of important differences among the experiences of the seven broad occupancies is in itself significant since it emphasizes the fact that before recommending a record container it is necessary to know more about an occupancy than simply that it is an office, warehouse or manufacturing plant. For example, Table No. 3 indicates that the contents of 10 per cent of the labeled containers in warehouses were destroyed as compared with 20 per cent in offices. This would imply that less protection need be provided for records in warehouses than

Table No. 3
Container Performance by Occupancy

Condition of Container and Contents After Fire	Manufacturing	Mercantile	Offices	Assembly	Storage	Residential	Miscellaneous	Totals
Labeled Containers								
Normal Containers	38%	37%	55%	20%	38%	40%	15%	36%
Abnormal† Containers	62%	63%	45%	80%	62%	60%	85%	64%
Contents Preserved	90%	91%	80%	91%	90%	60%	91%	88%
Contents Damaged	10%	9%	20%	9%	10%	40%	9%	12%
Cause of Destruction of Contents								
Doors Open	4	2	2	0	1	0	1	10
Exposure Judged Excessive*	7	4	3	1	2	1	1	19
Under Water	1	2	3	1	1	1	1	10
Other	0	0	0	0	0	0	1	1
Totals	12	8	8	2	4	2	4	40
Unlabeled Containers								
Normal Containers	24%	28%	46%	0%	28%	0%	15%	25%
Abnormal† Containers	76%	72%	54%	100%	72%	100%	85%	75%
Contents Preserved	65%	65%	54%	55%	47%	50%	58%	60%
Contents Damaged	35%	35%	46%	45%	53%	50%	42%	40%
Cause of Destruction of Contents								
Doors Open	0	4	1	0	2	0	1	8
Exposure Judged Excessive*	14	15	3	2	2	0	0	35
Not Insulated	1	1	0	0	0	0	2	4
Obsolete Type	13	10	5	2	11	2	8	51
Under Water	2	4	3	0	4	0	3	16
Other	1	0	0	0	0	0	0	1
Totals	31	34	12	4	19	2	14	116

†See footnote Table 1 for explanation of "abnormal" container.
*See footnote Table 1 for explanation of "exposure judged excessive."

in offices, which is certainly not true in a majority of cases. Before the degree and nature of the fire protection required for records can be estimated it is necessary to make a careful survey of the building and its occupancy in each area where the records are to be kept.

An example of the erroneous conclusions that may be reached from a superficial knowledge of the factors influencing intensity and duration of exposure can be obtained from a comparison of the two following warehouse fires.

On April 11, 1952 the contents of a 1-hour safe in a lumber warehouse at Worth, Illinois, was destroyed along with the unsprinklered, brick, wood-joisted building. The intensity and duration (two hours) of the exposing fire that consumed large quantities of stored lumber was judged responsible for failure of the safe to protect its contents. Obviously, the degree of protection provided for the records in this instance was inadequate.

Compare this fire with a fire in a builders' supplies warehouse at Colonie, N. Y., June 10, 1952. The building was similar in construction to that at Worth and the combustibility of the contents in both was about the same. In the Colonie fire, however, the contents of a 1-hour safe was preserved despite the fact that an eight-

Satisfactory performance of labeled doors at the second story level saved records in the second story of this 2-story vault. An unlabeled door at the first story level was damaged and records in the first story were destroyed. Picture below was taken during the fire.

hour fire destroyed the building. In this instance the fortunate location of the container permitted firemen to keep it cool with hose streams during the first four hours of the fire. Without all the details one might conclude from the Colonie fire that a 1-hour safe was adequate protection in a masonry, wood-joisted warehouse loaded with combustible building materials. When, however, the effect of the fortunate location of the safe within range of hose streams is taken into consideration, it must be concluded that the preserved contents can probably be attributed primarily to luck. In other words, a more accurate estimate of the performance of a 1-hour container in a builders' materials warehouse can be obtained from the Worth, Illinois, fire.

Labeled vs. Unlabeled Vault Doors

The performance of 53 vaults, all in buildings of other than fire-resistive construction, was studied. Ten of the eleven

The 2-story vault shown in the other picture on this page was in this 4-story brick, plank and timber constructed, sprinkler-protected hardware factory at Syracuse, N. Y. After the fire three sprinkler valves were found closed and a 30-pound piece of lead was found lodged in a sprinkler riser.

Standing alone in the midst of 100,000 sq. ft. of rubble caused by a fire which destroyed the Operations Building (a former hangar) at Moncton Airport on Oct. 4, 1951 is this two-story record vault. The contents of the vault on the first-story was found in perfect condition after the fire as the labeled vault door had been locked. The second-story vault door was open about a foot and records within 1 foot of the door were found charred. The balance were smoke damaged.

labeled 1-hour, 2-hour, 4-hour and 6-hour vault doors protected their contents in fires which lasted from one to more than eight hours. The single failure was due to the fact that the door of the vault was open.

Only 24 of 42 unlabeled vault doors protected their contents. Of the 18 vaults whose contents were destroyed, doors were open on two when the fires occurred. The remaining 16 failures were due to vault and vault door construction deficiencies:—obsolescence, lack of insulation, and exposure judged too intense for the type of construction.

Conclusions

The excellent protection provided by the labeled record containers and vault doors in the typical serious fires in this study is confirming evidence that protection of records from damage by fire can be assured when undertaken in a scientific manner.

As pointed out by the NFPA Committee on Protection of Records, protection against the maximum degree of exposure to which records may be subjected can be assured if the maximum exposure hazard is properly assessed and a record container designed to give protection against that degree of hazard is provided. Guidance in assessing the exposure hazard scientifically will be found in the pamphlet *Protection of Records.*

Assurance that a record container or vault door will provide the desired degree of protection can be obtained by selecting a container or door that has been tested and labeled by Underwriters' Laboratories, Inc., or other nationally recognized fire testing laboratory.

Representative Case Histories

Flying School, Teterboro, N. J., July 10, 1948

In addition to destruction of the 1-story masonry, steel-framed building, fire of two hours' duration resulted in complete loss of all records. The records were kept in steel desks and uninsulated steel cabinets.

Offices, Portland, Ore., Nov. 29, 1948

The only part of the 2-story wooden building to survive a gas explosion was a 2-story reinforced concrete vault with openings protected by 2-hour vault doors. Vital records in the vault were preserved.

Offices, Birmingham, Ala., Jan. 30, 1949

A severe fire of ten hours' duration destroyed this unsprinklered 4-story brick, wood-joisted office building and all contents except records kept in a 1-hour safe. During the fire the 28-yr.-old safe fell from an upper story into debris.

Steel Mill, Canton, Ohio, Mar. 16, 1949

Loss of valuable data is reported to have caused a 45-day delay in research and to have resulted in temporary shutdown of several mills. The loss of the not easily replaced data resulted when fire destroyed the research laboratory in the basement of the unsprinklered 3-story steel-framed building. At the time of the fire the data were in the open in the laboratory. Although the 1-hour door on an exposed record vault was warped by the intensity of the fire, all records in the vault were preserved.

Offices, Orange, Texas, Aug. 12, 1949

A labeled, 1-hour insulated file fell 20 ft. into the basement from a second story insurance agency office during a four-hour fire that destroyed the 2-story brick, wood-joisted building. The file with its contents of important records was removed undamaged from the debris.

Grain Milling, Peabody, Mass., Aug. 4, 1951

Added to the obvious difficulties of restoring milling operations after the 2-story wooden building was destroyed, were the handicaps in reaching a fair insurance adjustment due to loss of inventory records and original sales slips. These records were not kept in labeled record containers.

Truck Terminal, Boise, Idaho, Sept. 14, 1951

Destruction of the 20,300 sq. ft. undivided and unsprinklered warehouse was accompanied by explosions of ammonia cylinders that hampered fire fighting. Fortunately, however, the 1-hour labeled safe containing vital records was at the opposite end of the building from the explosions and firemen were able to keep it cool with a hose stream throughout the 6½-hour fire. The safe was slightly damaged but the records were preserved.

Offices, No. Little Rock, Ark., Oct. 14, 1951

The only records in the state purchasing agent's office to survive the one-hour fire that destroyed the 1-story wooden building were those kept in a labeled 1-hour insulated file. All other records in the building were in steel filing cabinets and were destroyed.

Lumber Yard, Rosslyn, Va., Dec. 28, 1951

The 2-story office and storage building was destroyed by fire of two hours' duration but, since vital records were preserved by a 2-hour insulated safe, the firm was able to go on with its business in rented temporary quarters. The safe fell with its contents from the second story and was buried in debris for 12 hours.

Metalworking, McHenry, Ill., Mar. 6, 1952

Payroll records kept in an obsolete cast iron safe were destroyed by fire that leveled the 1-story brick, wood-joisted plant. Ignition of quenching oil by hot steel was the reported cause.

Insecticide Storage, Whittier, Calif., April 1, 1952

Ledgers in an unlabeled safe were scorched by intense heat from a fire of three hours' duration that destroyed the unsprinklered 1-story wooden warehouse. Approximately 50 per cent of accounts receivable records in a 1-hour insulated record desk were destroyed and the balance damaged but legible. The desk was damaged by a falling object and was subjected to fire exposure in excess of its labeled rating.

Oil Warehouse, Stockton, Calif., August 3, 1952

Backfire of a truck caused fire that destroyed the unsprinklered 1-story wood-frame, metalclad building. Exposing temperatures of at least 1700°F during the early part of this 1½-hour fire severely damaged the outside of the 1-hour labeled safe. Vital records inside were preserved. Miscellaneous other records in uninsulated steel filing cabinets were destroyed.

Wholesale Drugs, Amarillo, Texas, Nov. 18, 1952

During a two-hour fire that destroyed the 1-story wooden building, vault walls collapsed due to faulty construction. Vital records, including accounts receivable totaling $30,000, were lost.

Management Push for Fire Safety†

Address by A. C. Schrier, Vice President
E. J. Brach & Sons, Chicago, Ill.

The first thing that management should do is to become educated in basic fire safety. "An ounce of prevention is worth a pound of cure." Most managements have a persecution complex every time a fire inspector comes into their plant. This comes from the basic feeling of being interfered with and also the fear that the inspector's recommendations will be unreasonable and will cost money. Believe me, gentlemen, money spent in fire protection returns dividends.

Codes developed for fire prevention are not political whims or fancies. They are the result of scientific observation and experience and are based on a record of causes of past disasters.

Management can quickly become educated by consulting with its local fire prevention bureau and acquainting itself with the bureau's rules and codes. Have a chat with your neighborhood fire chief and make arrangements for him to inspect your plant. Give him a plot of your plant and property so that the local fire department will know where your hydrants and sprinkler connections are located. Then, in case of a fire in your plant, there will be no time wasted.

Retain a good fire protection engineer on a consulting basis. Give him the opportunity to bring you up-to-date on basic fire prevention. Let him inspect your plant and follow his advice in correcting hazardous conditions. If you are planning additions or alterations to your plant, give him a chance to review your plans and make suggestions. I am sure that many of you consult experts in many phases of your business. What is more important than the protection of your business against fire?

Obtain the many excellent publications of the National Fire Protection Association. I am sure you will find a code for your type of business and many other valuable suggestions among the more than 300 publications on the various phases of fire prevention and fire protection published by this organization. These are some which you will find helpful: NFPA Handbook of Fire Protection; NFPA Inspection Manual; National Fire Codes, including Volume I, Flammable Liquids, Gases, Chemicals and Explosives; Volume II, Dust Explosions; Volume III, Building Construction and Equipment; Volume IV, Extinguishing and Alarm Equipment; Volume V, National Electrical Code.* These publications, and many others, are the result of many hours of work by men who are experts in these fields.

It is the duty of every executive to know what is important in fire protection so when he goes through his plant he can spot check fire equipment, stairs, exits, and electrical equipment.

Management can also push for fire safety by developing a standard practice for plant and equipment design. For example, be sure the electrical equipment is proper for the area. Be sure that the area is properly ventilated. Be sure that the fire fighting equipment is adequate and

†Based on address presented at the 57th NFPA Annual Meeting, May 18-22.

*All these publications available from the Association. For prices, ask for the NFPA "List of Publications."

of the right type. Be sure floor drains or scuppers are provided to minimize water damage. These are only a few of the many necessary rules of proper design.

Fire Preventive Maintenance

Management can push for fire safety by providing what I shall call fire preventive maintenance. This is a regular periodic check of the many safety devices built in your plant to protect it and your employees. A few of these are:

1. Regular replacement of the fluid in fire extinguishers.

2. Regular inspections of fire doors to see that the track and hinges are free from dirt and rust and that they operate freely.

3. Test your fire hoses periodically to see if they will stand the water pressure and if not, replace them.

4. Place extinguishers and fire hoses in locations that are easily accessible. When you change the layout of a department, be sure that you change the location of your extinguishers so that they remain on an aisle, for example, and are not behind a pile of stock.

5. Require periodic checking of explosion vents and catches on explosion-type windows to be sure that they work freely.

6. Periodic inspection and testing of fire pumps is a must.

7. Check your plant at least once a year to see if you have adequate portable equipment and that it is in the proper location.

8. Check safety devices on all gas or oil-fired equipment.

9. Require inspection of safety devices and piping on pressure equipment. Many plants use hydraulic presses and most of this equipment uses oil as the pressure medium. If a pipe should break, oil can spurt across the room and if the oil should come into contact with a hot surface a serious fire could result. Investigate the desirability of changing to a nonflammable hydraulic fluid.

10. Provide access doors in your ductwork and have the ducts cleaned at scheduled intervals.

11. Inspect your fire escapes to be sure that all the treads are firm and that the hinged portion works freely.

12. Inspect your sprinkler tank and valves to assure the system is in proper operating condition.

There are other items which should be included in this fire preventive maintenance program for special attention. I am sure that with the aid of your fire department, your fire insurance company and your consultant, a good and adequate program can be put into operation.

Standard Practices

Management should also develop a standard practice for operating hazards. A few suggestions for this program are:

1. Proper and strict rules for using a welding torch. Make someone in authority approve the place where a torch is to be used. Have a fire watch with an extinguisher at each welding operation.

2. Provide metal containers for waste paper and oily rags.

3. Constantly replace your temporary wiring with permanent wiring. Management has a habit of ordering the moving of machinery on a weekend and when a machine is hooked up with temporary wiring they forget to complete the installation.

4. Provide smoking areas and enforce no-smoking rules in hazardous departments. This is a difficult problem and requires constant vigilance and strict discipline.

5. Establish and enforce rules for the use and storage of the flammable materials that are used in your business.

All of the above suggestions are subordinate to good housekeeping. One

could take all the allotted space to discuss this important subject, but fundamentally if you have good housekeeping your chances of having a serious accident are greatly minimized.

Education and Drills

Management should provide and demand that its supervisory personnel be educated in the causes of fire. It should show films or demonstrate how to use fire extinguishers and which type should be used for each type of fire. It should organize a plant fire department with someone in charge who knows how and has had some experience in fighting fires. If you look around your plant you can find someone who has been or is a member of a volunteer fire department. If this person is not available, send one of your good supervisors to your local or state fire fighting school. Maintenance department employees usually make good firemen.

Provide fire drills or at least discuss the matter of exits with each foreman or supervisor. Be sure he knows which stairs are fire exit stairs and how he can lead his people out to the open. In this atomic age, this is a must.

After educating your supervisory personnel, require them to educate the people under their supervision. The supervisors should properly instruct their employees in the handling of hazardous equipment. Be sure this instruction is given before the employee starts to work. Psychology tells us that a pattern is established in a person's mind the first time he does a thing. If the pattern of handling hazardous equipment is properly set in an employee's mind, his chances of doing it wrong are much less than if he has started out with an improper method and then has to be corrected.

Management can push for fire safety by maintaining interest in it 52 weeks a year. Any bid for employee support of safety must start from the top. It must be built around the strong central figure of management with whom the employees can identify themselves. Management must give concrete evidence of its sincerity by action and by constant support of its fire safety program.

Developing Safer Industrial Trucks*

By O. S. Carliss, Director of Engineering

The Yale & Towne Manufacturing Company

The over-all problem of designing safer industrial trucks, like all design problems, involves certain technical compromises which must be made if the design is to achieve a reasonable degree of success.

The designer of industrial trucks must serve many masters and each of them well. He has an obligation to his customers each with somewhat different problems, as typified by the products handled with industrial trucks, ranging from pallet loads of orchids to rolls of steel weighing upwards of 80,000 lbs. He also has an obligation to the stockholders of his company who have invested their money and rightfully expect that these industrial trucks be sold at a profit. This is a highly competitive market and every design advantage must be taken in order to keep the cost of these trucks at a minimum. Compared with the automotive industry, the total unit volume is small, but the number of models is necessarily large.

Changes in product design which become necessary to meet newly developed standards are costly. It is essential that the designer consider carefully the proposed standards with which he must comply and the cost of the changes which he feels must be made in order to satisfy these standards. Hence, if he is to work with confidence he must feel that the standards are practical, adequate, and, within reasonable time limits, will not be subject to change, otherwise he cannot go ahead with necessary design modifications with any sense of confidence. In a capital goods industry, design changes are not dictated so much by calendar date as they are by real improvements and practical requirements. It is often advisable to so schedule improvements and developments that several changes or modifications may be made at one time, otherwise the design is in a constant state of flux and the cost of the product adversely affected.

Rugged and Safe Trucks Essential

Above all the trucks must be rugged and safe. Safety, from the fire protection engineer's point of view, is primarily the reduction of fire hazard. Other factors concerning safety are interrelated and cannot be considered separately.

The sole reason for the purchase of industrial trucks is to reduce material handling costs, hence in the minds of users the problem is strictly one of economics. If the cost of handling the material stored in warehouses can be reduced by the use of industrial trucks, then it is economical to use them. If, however, due to the increased cost of insuring the buildings and their contents, together with the cost of operating material handling equipment, the cost of handling is not reduced, then the use of industrial trucks should not be considered. Also, if the restrictions or the requirements of design of the truck are such as to so increase the cost, or by virtue of the added devices increase the size of the truck, that truck becomes too costly, or too unwieldy to operate. If, because of its size, the vehicle requires too much floor area in which to operate, its use is uneconomical.

*Based on address presented at the 57th Annual Meeting of the NFPA, May 18-22, 1953. Mr. Carliss spoke as a representative of the Industrial Truck Association.

Industrial trucks are subject to hard usage. They are required to operate in restricted areas, to stack loads to high levels. They must be capable of stopping in short distances when fully loaded, on the level or on ramps. Driver visibility is an important safety feature. Lateral and vertical stability must be carefully considered if the truck is to elevate loads to any height. These and many other mechanical safety factors must be considered by the industrial truck designer.

NFPA and Industry Cooperation Vital

The manufacturers of industrial trucks are, of course, vitally interested in producing equipment which will not increase the fire hazard of any property. Only through realistic cooperation between the NFPA and its associated groups and the designers of industrial trucks can this be accomplished.

One of our main problems, in both gasoline and electric trucks, stems from the required compactness of the equipment. As the users of this type of equipment become more skilled in employing industrial trucks, their demands increase for an ever smaller, more compact, higher capacity truck. Response to this requirement is clearly evident in some of the new models of trucks which are coming on the market. Also, as the user becomes more skilled in the application of this equipment the hours of service of the equipment per day increase, hence, more power storage is required, either in the form of larger batteries or greater gasoline tank capacity. The industry as a whole recognizes the need for guidance from the NFPA and the fire testing laboratories in some of these matters, particularly in the problem of testing components for use in trucks. Since the final decision on the use of trucks in a particular application is being investigated by the NFPA Committee on Industrial Tractors and Lift Trucks, we feel that this Committee should be in a position to give us clear cut, practical answers on the acceptability of components which we may select to use. I refer to temperature tests on internal combustion engines, mufflers, and exhaust systems, on electric motors, contactors, and resistors.

Fire Safety Tests Needed

I believe that the lack of adequate testing procedures to clear up questions pertaining to components in advance of the examination of the complete truck has in the past led to misunderstanding and misconception of the purpose of realistic and usable basic standards. Since your organization as a whole stands as the judge on the acceptability of this equipment, we urge that you take necessary steps to provide the means whereby we can obtain the guidance and the qualitative testing which is required.

It is far more desirable to have test approval for the selected components before the truck design is finally decided. The added costs involved in changing a completed design because it fails to meet or comply with new standards are prohibitive. The delays cannot be tolerated commercially.

Electric Trucks

In the design of electric trucks, particularly those for use in hazardous locations (as defined by Article 500 of the National Electrical Code), considerable work has been done. Through cooperation with the Underwriters' Laboratories, Inc. and the various manufacturers of electrical components, we have available today compact, well-designed electric motors which under normal operating conditions

do not reach excessive external temperatures. The industry as a whole has been able to develop resistor grids, enclosures, contactors, and temperature protective devices, all of which meet the requirements for operation in hazardous locations. It goes without saying that this material is more bulky and generally far more costly. The one major field problem in this type of equipment is the storage battery. This is not so much a temperature problem as the production of hydrogen in the normal operation. Underwriters' Laboratories have carefully established specifications for Type EX and Type EE Trucks,* and it is possible to design equipment to meet these specifications. However, all the efforts of the truck and battery manufacturers are lost unless the user of the equipment exercises proper precautions when using and servicing this equipment.

Liquid Fueled Trucks

The gasoline or diesel engine is a very desirable prime mover for application to industrial trucks. It is a self-contained power unit carrying an easily handled fuel. It affords certain economies of manufacture which consequently permit the use of such trucks in a much wider field of activity. Its safe use has been proven in the millions of cars, trucks and buses on the streets today.

The use of internal combustion engines in industrial trucks does present some special problems. In the first place there are more accessories to be located in an already crowded area. A radiator is required and this must be located so that cooling air will pass through it freely. The external temperature of an engine is naturally higher than is usually found in electric motors. The engine produces quantities of exhaust gases which must be conducted away from the engine. The designer endeavors to incorporate these elements into a truck, keeping in mind the need for compactness, minimum weight, mechanical stability, the rough usage to which the truck will be subjected, and the requirement for continued performance without excessive maintenance. The practical size of the vehicle limits the opportunities of the designer in many respects.

The men responsible for the design of industrial trucks are, by and large, engineers. If a piece of equipment functions satisfactorily, the design is judged as good. If there is some consistent failure of an element of the design, then the design engineer will take the necessary steps to correct that particular difficulty. This same thinking applies to the fire hazards of industrial trucks. The engineer responsible for the design must have available the fire records of past performance of the equipment to apply corrective measures.

Industrial Truck Fires

In an effort to determine where our designs might be improved to reduce the fire hazard of industrial trucks, a statistical analysis was made by the industry. The nature of data available limits the accuracy of the analysis, but it does serve as a guide. Further, the growth in the use of industrial trucks has been rapid. Hence, we must not be misled by the number of incidents but more properly by their relative frequency if we are to do a good design job.

The following usage figures were obtained from statistics compiled by the United States Department of Commerce

*See Underwriters' Laboratories "Standards for Power-Operated Industrial Trucks" (Subject 583), as revised June 1952.

and the Industrial Truck Association. They are reasonably valid.

Table 1.
Industrial Trucks in Operation

Year	Electric Trucks	Gasoline Trucks
1940	25,000	5,300
1945	40,000	94,000
1950	54,500	154,000
1952	67,661	206,548

During the period 1928 through 1945 the average number of gasoline trucks in use has been estimated at 14,000. During this same period 121 fires were reported. Of these, 71, or 58.7 per cent, were traced to fueling, and 50, or 41.3 per cent, to other causes.

During the period of 1942 through 1951 where the figures are more accurate, the average number of trucks in use has been estimated at 104,000. During this period 268 gasoline truck fires were reported. Of these, 145, or 54.2 per cent, were traced to fueling and 123, or 45.8 per cent, were traced to other causes.

The reduction in incident is noteworthy and can be attributed to improved design, maintenance, and operation.

Many of the fires classed as attributable to other causes are beyond the control of the designer. These include accidental overturning, collisions, and in at least one instance, the overturning of a salamander. No design standards can cover this type of incident.

In an effort to clarify in the minds of truck designers the practical requirements for added devices to help reduce fire hazard a user survey was conducted. Questionnaires were sent by members of the Industrial Truck Association to users covering trucks engaged in general warehousing, outside storage of combustible materials, piers and wharves, railroad and highway truck loading, airports, and aircraft production, and general indoor and outdoor use in manufacturing and processing. Answers were received from 586 users who reported on 6,398 trucks in use from one to over five years. A total of 85 fires were reported, or assuming that no truck experienced more than one fire, 1.33 per cent of the trucks in use were involved in fire. Sixty of the 85 fires, or 70.5 per cent, were extinguished with no apparent loss; 23, or 27.1 per cent, with loss of under $10,000; and only in two cases did the loss exceed $10,000.

Fire Causes

The analysis of the causes of the fires (Table 2) is even more illuminating. You will note that 74 of the 85 fires reported are generally beyond the control of the truck designer. The 8 fires attributed to defective wiring and grease or lint on the motor are basically improper maintenance. I feel sure that the wiring was sound when the truck was built, since all truck manufacturers follow accepted automotive wiring practices. The three fires attributed to backfiring may be to a large extent attributed to maintenance also.

Table 2.
Causes of 85 Industrial Truck Fires

Cause	No. Fires	Per Cent
Careless fueling	74	87.1
Defective wiring and grease or lint on motor	8	9.4
Backfiring adjacent to combustible material	3	3.5

The space available for a muffler is naturally limited, hence the incorporation of elaborate arresting devices such as are found on some mine locomotives is impractical. When we examine the available statistics we frankly question just what is realistically needed.

From the statistics available it appears that the gasoline truck as it stands today is a safe and usable piece of industrial equipment. We do need the guidance which can be obtained from complete statistical analysis of fires attributed to industrial

trucks, if we are to view this problem realistically.

Operational Precautions Important

Much work has been done. The industry as a whole today is using approved type gas filler caps, and using many other elements as spelled out in the Underwriters' Laboratories "Standards for Power-Operated Industrial Trucks." The fuel tanks used in industrial trucks today are so mounted that accidental spillage of gasoline during the filling operation will not strike any hot part of the engine. However, we do know that a certain percentage of the fires reported each year are attributed to filling and we can only

WHAT EVERY EMPLOYEE SHOULD KNOW!
SAFE OPERATION of INDUSTRIAL TRUCKS
Based on Recommendations of
NATIONAL FIRE PROTECTION ASSOCIATION
SAFE REFUELING RULES
1. Return truck to location designated for refueling.
2. Stop engines before refueling.
3. Prevent spillage of fuel. Clean-up any spills before re-starting engine.
4. Maintain contact between side of fill opening of tank and hose nozzle during fueling.
AVOID DAMAGING FIRE EQUIPMENT
1. Avoid striking sprinkler heads, pipes, fire doors, extinguishers, etc.
2. Keep fire aisles and access space to fire equipment and exit doors clear.
KNOW HOW TO USE BRIDGE PLATES
1. Secure bridge plates and operate carefully and slowly.
2. Sides of bridge plates should be turned up at right angles or other means provided to prevent run-off.
OPERATE AND STOP TRUCK SAFELY
1. Do not attempt repairs or adjustments unless authorized.
2. When leaving a truck unattended:
a. Neutralize controls
b. Shut-off power
c. Set brakes
d. Remove key or disconnect battery
e. Leave forks of fork trucks flat on floor
3. Garage trucks only in locations specified.
4. Do not exceed speed limits: slow down at aisles or when vision is obstructed by doors, corners or elevators, and on slippery or wet floors.
5. Keep truck under your control at all times so a quick stop can be made in an emergency.
6. Always look in the direction of travel.
7. Avoid parking on incline whenever possible; when unavoidable place chocks under drive wheels as well as setting brakes.
8. When driving fork trucks, keep forks as low as conditions permit.
9. Do not tow railroad freight cars with industrial trucks.
10. Avoid stunt driving and horse-play!
WATCH YOUR LOADS
1. Report leaky containers and broken packages to the foreman or supervisor.
2. Know the load capacity of your truck and do not exceed it. Do not counterweight a fork truck to increase its lifting capacity. Use care when tilting a load forward or backward.
3. Where high tiering is necessary, provide special overhead protection for the lift truck and yourself.
4. Do not use elevators unless specifically authorized. Know relation of weight of truck plus its load to capacity of elevator. Shut-off power, set brakes and neutralize controls of truck while on elevator.
LOADING ON RAILROAD CARS
Assure that positive protection has been provided to prevent railroad cars from being moved while bridge plates are in position and men working across them.
It's Your Job — Your Responsibility
GOOD JOB
BAD FIRE
NO JOB!
Copyright, 1953, National Fire Protection Association, Boston 10, Mass. (NFPA 302C-1)
Additional Copies $1.00 doz.

This is a reproduction of a 9 x 12 in. poster (red and black) available from the National Fire Protection Association at $1.00 a doz. (Single copies free).

surmise that proper operational precautions were not taken. I think that we must all recognize the limitations on the designer and the responsibility of the operator in these instances.

We feel that considerable work must be done to promote safety in the use of industrial trucks as well as to design safety into industrial trucks. The sphere of influence of the designer is definitely limited to his own corporation and in fact within his own plant facility. Once the product leaves the plant, he has no control over its application or use. Herein lies a major area of difficulty which can only be cleared up by the cooperation of the manufacturer, the National Fire Protection Association, and the users. The misuse of equipment, or the use of procedures which would lead to difficulty no matter what type of equipment was involved, creates a great area of misconception and misunderstanding.

Safety Education by Manufacturers

The industrial truck industry realizes that it has a considerable responsibility in the proper instruction of users of equipment. I believe that the manufacturers, without exception, have provided rather adequate material for the proper instruction of drivers and maintenance personnel. The Clark Equipment Company has recently made available to industry an exceptionally fine film on safety. This film is being cited by many people outside of the industry as one of the better safety films available today. The Towmotor Corporation provides a fine set of posters and informative data as well as definite instructions for drivers and maintenance people. The Yale & Towne Manufacturing Company has a complete driver training program and a service and maintenance training program with slides, instruction manuals, and complete instructor manuals, so that the course for the drivers and the course for the service personnel are self-contained and can be handled by someone on a job-training basis. I cite these three as examples of what the industry is doing. These are representative of the activity of the industry in tying in safety and maintenance. We feel that a major contribution can be made by your organization in further fostering and stressing this important factor in the operation of industrial trucks.*

NFPA-Industry Cooperation

The industrial truck industry is most fortunate in having the NFPA Committee on Industrial Tractors and Lift Trucks to work with us on these problems. It is no small problem to reconcile the divergent views of the manufacturer, the user, the insurer and fire officials and to arrive at a realistic, workable, compact set of standards under which no one suffers. The development of reasonable standards is well worth all the effort expended.

*See NFPA Pamphlet No. 505B-C, "Standards for the Maintenance and Safe Operation of Industrial Trucks" (25 cents a copy, discount for quantities).

Christmas Tree Hazards And Treatments

By George H. Tryon
Assistant Technical Secretary National Fire Protection Association

This article deals with the fire hazards of Christmas trees and current data on the treatment of Christmas trees to increase their fire resistance.

Position of NFPA

The position of the National Fire Protection Association on this matter should first be explained. The NFPA continues to be very much concerned about the special fire hazards of Christmas trees. It does not, however, have testing facilities to evaluate the effectiveness of the various treatments proposed for reducing the combustibility of Christmas trees. It has also proved to be a thorny problem to establish conclusive testing procedures for use by local fire departments and similar agencies which would include all variables—different types of trees, cut at various times, subject to different weather and humidity conditions, and treated with varied skill by spraying or dipping.

It has been the published recommendation of the National Fire Protection Association that:

> "Freshly cut Christmas trees, sawed off at an angle at least one inch above the original cut and kept standing in water during the entire period they are in the house, adding water at intervals to the jar or tub in which the tree stands to keep the water level above the cut, will reduce their extreme flammability."

The principle of setting a tree in water is that the tree will absorb the liquid and keep it from drying out for a longer period of time than would otherwise be the case. The limitations are that the age of the tree affects its absorption abilities and congealing of tree sap in the veins or sap ducts prevents the water from reaching certain branches or the entire tree.

The same limitation as above applies to fire-retardant solutions of calcium chloride or ammonium sulphate in water

Cover reproduction of the new 1953 two-color NFPA special Christmas folder. You can help by distributing these to your friends and neighbors.

which have been advocated for this same purpose.

Whether or not a tree is set in water, every precaution should be taken to eliminate potential ignition sources. This subject is discussed on pages 184 and 185.

Agriculture Department Statement

The U. S. Department of Agriculture in their leaflet No. 193 "Fireproofing of Christmas Trees" gives formulas for ammonium sulphate and calcium chloride solutions.

The Forest Products Laboratory has more recently found that ammonium sulphate will cause discoloration of spruce and balsam fir needles and they, in essence, recommend that plain water be used instead of either solution.

Commercial Testing Laboratories

In recent years, particularly in the last two years, a number of firms have been manufacturing and advertising Christmas tree flameproofing compounds for *external* application. A few of these have been tested by commercial testing laboratories but the lack of a standard testing procedure has restricted the value of the results obtained. Without a standard method of test, results cannot be realistically evaluated or effectively duplicated.

California State Fire Marshal Tests

The following trade name products have been tested by the State Fire Marshal of the State of California and are listed in their "Approved List of Flame Retardant Chemicals, Fabrics, Materials and Application Concerns" (Sept. 1, 1953) as suitable for Christmas Trees under a test program established by them.*

*This list is subject to revision periodically and the State Fire Marshal's Office should be consulted for the latest listings by those interested (1100 So. Grand Ave., Los Angeles).

Courtesy Hardy Wessell

The Houston Junior Chamber of Commerce Fire Prevention Committee had these signs erected at Christmas tree sales outlets in the Houston area.

C & S Flameproofing Preservative
C & S Coatings Company
5887 Blackwelder Street
Culver City, Calif.

Fire Chief Concentrate
Western Canvas Finishers
1680 N. Miller Avenue
Los Angeles 33, Calif.

Flamemaster Safecoat
Flamemaster Safeguard
Ideal Chemical Products, Inc.
3813 Hoke Avenue
Culver City, Calif.

Flame Proof Xmas Tree Oil Paint
Hughes Paint Company
5924 S. Western Avenue
Los Angeles, Calif.

Flamort Plastic Coat Clear
Flamort Chemical Company
746 Natoma Street
San Francisco 3, Calif.

Protex Fire Retardant Coating
Admiralty Manufacturing Company
825 27th Avenue
Oakland, Calif.

Q. R. S. Official #8 Conc., #23 Conc., #57 Weatherproof
Q. R. S. Neon Corp., Ltd.
170 N. Halstead Street
Pasadena 8, Calif.

Safetree
Kwitz Chemical Corp.
425 Bryant Street
San Francisco 7, Calif.

The California program involves applying the chemical to fresh green branches of Douglas Fir, approximately three feet long. The fire-resistance test is performed at the completion of a 30-day aging period. The tests include that there shall be no spread of flame from the area in contact with the test flame nor any after-flame longer than 10 seconds. The

treated branch shall also not lose its needles more readily nor turn brown to a greater extent than those of the untreated branch similarly aged. In listing those chemicals the California Fire Marshal states:

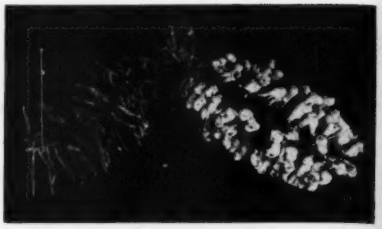
> "Although certain chemicals (as noted above) are listed as approved for the treatment of Christmas trees, conditions of use may render such treatments partially ineffective. Therefore it is required that, in addition to any chemical treatment, all trees used as decorative materials and falling within the jurisdiction of the State Fire Marshal's Office shall have the base freshly cut at a 45 degree angle and placed in water or wet sand to prevent drying."

California is the only state where, to our knowledge, there is such a program.

It is not the intent of the California testing program that those products approved by them would find much use by private citizens treating trees in their homes. It is the opinion of the California State Fire Marshal that the variations in species of trees, length of needle and age after cutting are not important factors where external coatings are used. This is in distinct contrast to the importance of these same factors where the absorption method is used. The strength of the California program is the fact that the State Fire Marshal's Office has policing power over the chemical industry as well as the application concerns. They point out that the best chemicals will fail if not properly applied.

Monsanto Product

Another chemical that has been used to treat Christmas trees externally was made experimentally by the Monsanto Chemical Company (1700 South Second Street, St. Louis, Missouri) under the trade name "Fire-Retardant T." We understand that Monsanto is willing to license manufacturers to produce this product under their patent rights (U. S. Patent 2,526,083) but we do not know if it is being so produced at this time.



The Monsanto product is for external coating. Note intumescence of coating after exposure on right side. Left side is a treated branch before heating.

Underwriters' Laboratories

Tests have been conducted by Underwriters' Laboratories Inc. but no flameproofing treatments have been listed by this organization as yet. Their tests have consisted of determining the fire exposure needed to consume full-sized untreated green trees and then exposing other treated full-sized green trees within 48 hours, 30 days and 60 days after treatment. The trees tested have included four species of evergreens from each of the three major areas where Christmas trees are cut in this country. The trees were exposed to a fire consisting of one pound of shredded newsprint distributed annularly at the base of the tree. Underwriters' Laboratories feel that these tests on full-sized treated trees are very desirable since small-scale tests on branches often give inconclusive or misleading results.

No treatments yet tested on full-sized trees have convinced Underwriters' Laboratories that any relaxation of the usual precautions to prevent the ignition of

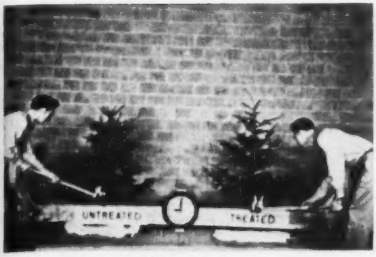


Figure 1

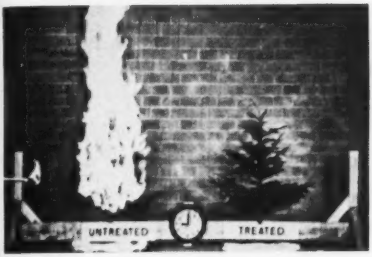


Figure 2

Typical test of treated and untreated trees. Figure 1 shows relative burning after 3 seconds; Figure 2 after 6 seconds. The tests illustrated used the Monsanto "Fire Retardant T."

Christmas trees are justified. Some treatments are not only ineffective in preventing the spread of flame but also liberate volumes of smoke and fumes beyond those normally given off by a burning untreated tree.

Underwriters' Laboratories are of the opinion that setting Christmas trees in plain water, as has been advocated by the NFPA for many years, may reduce the ease of ignition of the tree to some extent, depending on the circumstances. Even with this precaution, however, Christmas trees still present a very severe potential fire hazard. They look forward to the development of treatments which will materially reduce the hazard, but, in the meantime, they urge that the limitations of present flameproofing treatments be recognized and all possible precautions be taken to prevent tree ignition.

Absorption vs. External Applications

It must be concluded that the absorption method using fire retardant chemicals is generally unsatisfactory and is markedly influenced by many variable factors such as the species and size of the trees and the length of time elapsed since being cut. The use of plain water has advantages but should not be relied upon to maintain a tree in fresh condition.

The compounds for external application discussed above are trade secrets of the manufacturers and we do not know their exact composition except for the Monsanto product which is patented. Monsanto advises their product is made of the following ingredients:

Borax .....56 parts by weight
Boric Acid .....24 parts by weight
Diamonium Phosphate
20 parts by weight
Santomerse D (a wetting agent)
0.25 parts by weight

This solution, however, cannot be satisfactorily mixed in "homemade" style as it takes laboratory facilities to secure the proper solubility and viscosity.

Another external solution is composed of nine parts by volume of sodium silicate (water glass) and one part water containing a wetting agent, such as any of the detergents, "Dreft," "Vel," "Breeze," etc. It might be possible to make this solution in the home but no guarantee can be given that it will be satisfactory or that it will not result in needle falling. The use of various colors of water-based paints on Christmas trees by dipping or spraying may also reduce its flammability but likewise no guarantee can be offered as to the fire-retardant effectiveness of such treatments.

Discoloration of the green and premature falling of the needles occur with certain chemical absorption and spray applications. Note that the California regulations are specific in this regard. Similarly, as we have indicated before, there is no sure way of predicting how they behave on the different types of trees and how effective they are when applied to trees cut at different times prior to fire retardant treatments.

Conclusion

It can be seen from the above that, generally speaking, the problem is an unsolved one. California reports they have not had any fires in trees that were treated as they specify and that thousands of such trees are treated each year. Some local fire departments in other parts of the country are offering to spray or dip trees with one or more of the solutions mentioned herein and we have had reports that their programs have been successful. How much of this success is due to the treatment that the trees receive and how much to the psychological awareness of the fire hazard of the tree by the public who secure this service cannot be estimated.

It is our opinion that the following safeguards to eliminate ignition sources around Christmas trees will do a great deal towards eliminating the life and property hazards and that they should be followed regardless of any treatment provided for the tree:

The Tree

1. Cut a growing tree or purchase one which shows it has not been allowed to dry out by prolonged storage. When too dry, tree branches are brittle and shed needles easily. (Test flexibility of small branches and retention of needles.)

2. Stand the tree in water or snow outdoors until you are ready to use it indoors.

3. Bring the tree indoors just before Christmas and remove it as soon as it has served its purpose. (December 26 is recommended.)

4. The larger the tree, the greater the hazard, so do not get one any larger than you need.

5. Just before setting up the tree, saw off the trunk at an angle at least one inch above the original cut.

6. Place the freshly cut tree trunk in water and keep level of water above the cut the entire time the tree is indoors. (Check the water level at least once a day for absorption and evaporation.)

7. Support the tree well. Keep it away from sources of heat (fireplaces, radiators, etc.) and place it so that, standing or fallen, it could not block the way out of the room or out of the house in case of fire.

Lighting

8. Do not use wax candles on the tree or nearby where there is any chance for an open flame to contact the tree or combustibles piled beneath the tree.

9. Use only electric lighting sets that bear the UL (Underwriters' Laboratories, Inc.) label.

10. Check lighting sets each year *before* using, for frayed wires, loose connections, and broken sockets.

11. Be sure the fuse of the electric circuit serving the tree is not over 15 amperes. Cord sets with a fuse in the plug, bearing a UL label, are available. Do not plug too many cords in one outlet.

12. If any extensive holiday wiring is indicated call a competent electrician; do

not try to do it yourself, unless you are so qualified.

13. Make certain that all tree lighting is turned off before retiring or leaving the house.

DECORATIONS AND WRAPPINGS

14. Do not let combustible Christmas wrappings accumulate in the home; place them in a metal covered trash barrel or burn them in an incinerator at a safe location as soon as possible.

15. Use noncombustible material (metal, glass, asbestos, etc.) to decorate the home for Christmas wherever possible. When you must use combustible materials, be sure they are "flameproofed," particularly if they are to be placed near the tree.

16. Untreated cotton batting, paper and certain cloth costuming will ignite quite easily and burn with great intensity unless they are "flameproofed." Santa Claus' whiskers have caused Christmas tragedies; be sure they are "flameproofed."

17. Do not use the fireplace to burn Christmas wrappings and decorations. Guard against flying sparks from a fireplace with a substantial screen.

GIFTS

18. Don't buy pyroxylin plastic dolls, toys or "non-flameproofed" children's playsuits. Toys operated by alcohol, kerosene or gasoline are especially dangerous; they may upset and set fire to children's clothing, the tree or the house itself.

19. Look for the Underwriters' Laboratories label when buying electrical toys. This means they have been tested for fire and shock hazards and may be considered safe if properly maintained.

20. Do not set up electric trains or spirit-fueled toys under a Christmas tree where they might be responsible for upsetting the tree or igniting it.

21. Film projectors (toy or adult) should be labelled by the UL and should only use safety film (acetate stock).

IN GENERAL

22. Do not allow smoking near the tree, amidst decorations or wrappings. Have plenty of safe ash trays around and use them.

23. Keep matches, candles, etc. away from young children not trained in their hazards.

24. Plan on what *you* must do *if* fire breaks out.

25. Have operative water-type fire extinguishers, buckets of water or a garden hose connected to a faucet, within reach of the tree. *But remember unless you are sure you can put a fire out immediately, call your fire department at once.*

New Developments In Safe Paint Spraying

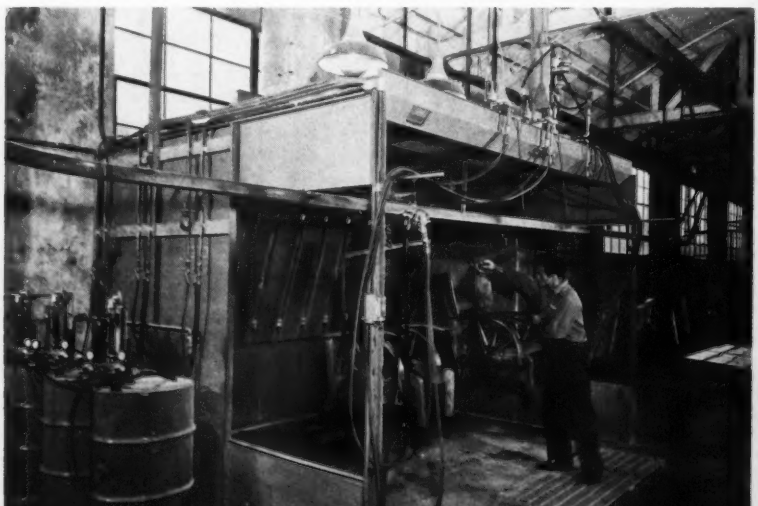
By Frank R. Pitt, Secretary
National Spray Painting and Finishing Association
Member, NFPA Committee on Finishing Processes

A majority of industrial products are produced on conveyor lines in American factories today. This has led to significant developments in the manufacture of improved paint spraying systems, exhaust equipment, drying ovens and circulating systems which supply the coating materials to the spray line under the most advantageous conditions. Such techniques have stimulated the drafting of modern fire safety recommendations and the NFPA Standards for Spray Finishing Using Flammable Materials (No. 33) are widely accepted by industry and in many cases have been enacted into law for the protection of the public.* These safety standards must be constantly reviewed to keep them up-to-date with new methods and equipment improvements.

Origin of Spray Painting

Spray painting equipment was first used in 1893 for painting the exteriors of the World's Fair buildings in Chicago.

*NFPA Pamphlet No. 33 is available from the Association for 25c a copy.



Dry-type spray booth and conveyor system illustrating circulating air-operated pumps employed in pumping material to spraying station at face of booth.

Since that time, manually operated spray guns have been used, not only for the painting of buildings and industrial structures, but also in every branch of industrial finishing. Steady improvements in the components of spray painting equipment including spray guns, air and fluid regulators, paint cups, pressure tanks, hose and connections have all materially contributed to fire safety in that greater controls were established over the operations and mechanical failure has been substantially eliminated.

Electrostatic Applications

Electrostatic application of protective coatings has been quite widely adopted during the postwar years and offers many advantages in those situations to which it has been adapted.* A basic principle of physics is involved in this method of finishing in that the object to be coated is of opposite polarity from the charged paint particles which are sprayed upon it. By spraying finely atomized paint through a system of negatively charged grids, such negative charges are imparted to the paint particles which are thereupon attracted to the material to be coated which is grounded to the conveyor and, hence, by inference, is of opposite polarity (positive).

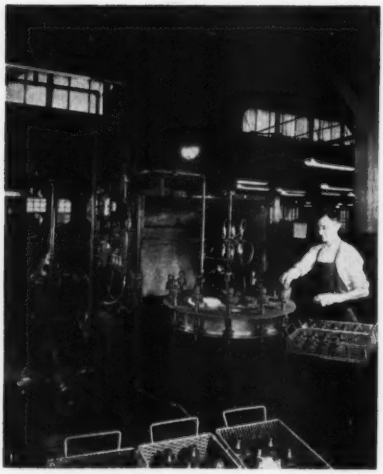
Obviously, changes in the design of both spray painting and exhaust equipment had to be made in order to accommodate this development. This, in turn, has required modifications to recognized principles promoting safety in spray finishing establishments. Chapter 9 of NFPA Pamphlet No. 33 (Standards for Spray Finishing Using Flammable Materials) specifically prescribes the rules to be followed to insure safety in using electrical equipment which involves exceedingly high voltages (up to 120,000 volts), although the amperage is exceedingly low (around one-half to one milliamp). To date, the safety record of such equipment with respect to both personnel and plants has been very good.

Inasmuch as this process is largely automatic, controls are installed to interrupt the power supply if there is either a failure of the ventilating system, a stoppage of the conveyor line, if a grounded object comes within the critical discharge distance of the electrode, or if sparking conditions are created. These last two conditions most frequently are caused when the object being coated comes too close to the electric grids.

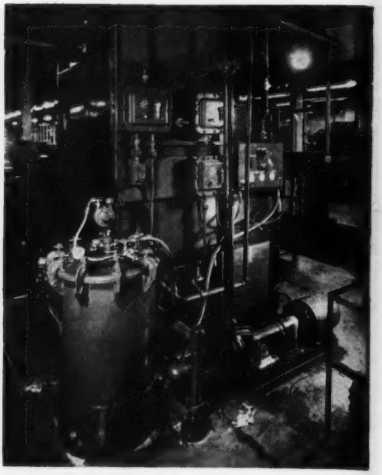
Low atomizing pressures are used in the electrostatic process. As the efficiency of this operation is greatly impaired if excessive air currents are introduced into the spray booth, the rate of air exhaust from the booth is carefully controlled. The amount of air moved is less than is needed to safeguard conventional paint spraying operations because there is much better control over the amount of overspray. The amount of paint, and thus the amount of solvent vapors in the air, is reduced by virtue of the greater spraying efficiency of the electrostatic application.

A recent variation of this process is the use of centrifugal spray heads. This technique utilizes centrifugal force whereby paint is pumped to rapidly revolving spray heads (or "bells"), from whose sharp outer edges paint is released in a fine spray. This spray is likewise negatively charged and the article to be painted is of opposite polarity, as described in the preceding paragraphs.

*See NFPA *Quarterly*, January 1947, page 163 for further information on "Electrostatic Paint Spraying and Detearing."



Front of rotary automatic machine and water wash booth.



Side view of rotary booth illustrating explosion-proof controls, enclosed motor.

Personnel Hazards Reduced

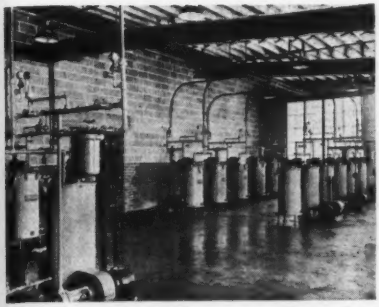
The genius of the American productive system to convert manually performed processes into machine operations has been widely evidenced in the finishing processes industry. The trend received great impetus during World War II and has recently been further advanced. From the fire protection engineer's point of view, this is normally a desirable development because it eliminates still further the human element which has proved to be the most likely source of the fire hazards associated with finishing processes. Proper design of the machinery and an engineered approach to the fire safety requirements of the automatic methods is, however, an important requisite to accomplish this theoretical benefit.

Heated Coating Materials

During the last four years, there has been an increased interest in the use of heated coating materials. This technique was originally sponsored by some of the principal manufacturers of lacquers, and has subsequently been promoted for synthetic enamels. Among the advantages claimed for the use of heated materials are: (1) lowered viscosities, (2) reduction in atomizing pressures, (3) less use of solvents, (4) improvement in the "flow-out" qualities of the material, (5) heavier depositions of material, (6) less overspray and (7) the elimination of "blushing." The reduction of overspray is a positive advantage to the fire protection engineer. The process of heating coating materials obviously introduces an added fire hazard but the listing of several types of electric heaters by Underwriters' Laboratories for this specific purpose has permitted acceptance of this method. Of course, the use of open flames or electric heating equipment not suitably protected would be hazardous.

High Pressure Spraying

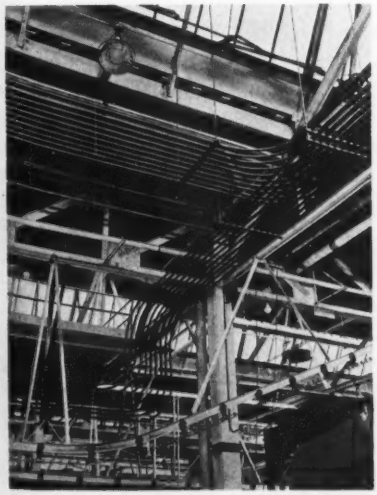
During the last year, new interest has also been created in high pressure spray



Typical paint mixing room illustrating mixing tanks, explosion proof motors and lines carrying material to spray stations.

painting using operating fluid pressures of 300 to 600 pounds-per-square-inch. This has been tried previously on several occasions, but the current interest is more promising because of allied improvements making possible a better breakup of materials by the heating techniques previously discussed.

The advantages claimed by the industry for this method of spraying are: (1) it eliminates the use of compressed air, (2) permits the saving of solvents in the application of paint, (3) reduces the amount of overspray which results in savings of material and reduction in maintenance and housekeeping expense, (4) reduces the amount of air required for ventilation and permits a heavier deposition of paint which, in certain types of applications, gives a two-coat effect with one coat application.



Circulating system (pipes at ceiling height) for delivering product to spraying locations. Closed system eliminates handling flammable liquids in open containers.

The high-pressure method can briefly be described as follows: The paint, lacquer or synthetic enamel to be applied, can be used either directly from its original container (if properly designed) or from a pressure tank or circulating system. The material is taken from the container through a large diameter solvent resistant fluid hose by the suction developed by the pump. It is then pumped through a paint heater which increases the temperature (160-200°F.) and then through a high pressure, solvent-resistant hose to the spray gun. The material not used by the spray gun is returned through a second high pressure, solvent-resistant hose (through a pressure regulator which is set to develop the necessary operating fluid pressure of from 300-600 pounds-per-square-inch) to the suction side of the pump and is recirculated constantly by the pump through the heater up to the gun and back again. The same principle of operation is employed for material that is delivered to the pump from a pressure tank or from a circulating system.

Steam Spraying

Experimental work has been conducted in the application of paint by the use of superheated steam, the steam being substituted for compressed air. Among the advantages industry claims for this meth-

od of application are: (1) savings in material and thinners, (2) the substitution of low cost steam for compressed air, (3) fewer cleanings of the spray booth because of reduced overspray, and (4) heavier film thickness per application.

Obvious safety considerations include proper location of boilers and superheaters in areas removed from the spray booth and protective clothing and gloves for operators to prevent hot steam hose from coming in direct contact with the human body. Steam piping should be grounded and all connecting pipes insulated.

Quick Drying Catalysts

No discussion of current developments in the finishing field would be complete without reference to the use of catalysts to promote the drying of finishes and coatings. It has been ascertained that the introduction of certain chemicals into most industrial finishes results in greatly shortening the drying time. This is an advantage from an industry viewpoint because expensive drying ovens can be reduced in size, products requiring more than one coat can have coats subsequent to the prime coat applied at minimum time intervals, and the finished product thus becomes more rapidly available for final shipment.

It has been found that the most effective way to introduce the catalyst into the material being sprayed is by means of a supplementary spray. If this process should be widely adopted, there would be a lessening of the possibility of hazardous conditions because the number and size of drying ovens would be reduced, and there would be a considerable shortening of the time immediately after spraying during which newly painted stock might give off flammable vapors. The use of various formulations of paints may, however, introduce spontaneous heating of residues and care must be exercised to avoid hazards from this cause.

General Safety Precautions

The NFPA Standards for Spray Finishing using Flammable Materials (No. 33) contain the fundamental rules that should be observed in the application of materials by the spray method.

The principal hazards of spray application are due to the flammable vapors and liquids and the combustible residues which may be deposited in the area of spray operations. For exterior and maintenance painting, as distinguished from industrial finishing, there is little to fear from the accumulation of overspray residues, as the nature of the operation results in almost all of the paint being applied to the surface at which it is directed. Further, exterior painting rarely results in the creation of a hazardous atmosphere due to the effects of natural ventilation. The same basic precautions should be observed in interior maintenance painting that are observed in industrial finishing.

To prevent fires and explosions, it is important to eliminate sources of ignition, and, by controlled ventilation, to maintain an atmosphere below the lowest explosive limits of the flammable products used. Properly designed spray booths are constructed to provide these safeguards for all phases of industrial finishing.

General Spray Booth Precautions

Open flames and spark-producing equipment are the principal sources of ignition and experience has dictated that if open flames and spark-producing equipment are kept out of spray booths and their exhaust ducts, fire hazards may be nearly eliminated. Today good practice dictates that spray booths be illuminated

Water-wash refinishing booth lighted from top with sealed glass panels. Note filter doors to clean air (doors closed while spraying is being done) and motor on outside of stack.

through glass panels which are sealed in position to prevent the escape of vapors into the area occupied by the lighting fixture. Where this is not practicable, lights should be placed upon the open face of a booth, and such lights should be protected from mechanical injury, and enclosed to prevent hot particles falling on freshly painted stock, or into other readily ignitible materials (open paint cans).

By the same token, electric motors and switches should be installed outside of a spray booth, and if located within 20 ft. of the open face of a booth should conform to the provisions of Section 5130 of Article 510 of the National Electrical Code (1953 Edition).* It cannot be emphasized too strongly that portable electric lights should not be used in any spraying area during spraying operations, and adequate controls should be installed to insure this result.

No lights, including those approved for Class I locations, should be installed in spray booths where overspray can be deposited because the globes may be heated sufficiently to ignite such deposits.

Hazards of Residues

Experience has clearly shown that spontaneous ignition of residues inside of ducts and booths is the cause of almost half of all fires involving spray painting establishments; consequently a continuing program of education and plant maintenance is necessary to control this source of ignition.

*Copies of the 1953 Edition available from the Association; Deluxe cloth-bound edition: $3.00; Paper-bound edition: $1.00.

Repair of Spray Booths

Another major cause of spray booth fires in large industrial plants is the failure to observe due care in repairing spray booths and connecting ducts. Experience has proven that where it is necessary to obtain a permit from the plant superintendent before repairs can be made to such installations, and specially trained employees are assigned to supervise such operations, practically no loss is experienced. On the other hand, such foolhardy practices as cutting into an exhaust duct which may be heavily coated with paint or conducting welding operations in the vicinity of a spray booth when there are open cans of paint and thinner exposed, have caused some serious life and property losses.

Other Spray Booth Precautions

Non-sparking fan blades are almost universally employed today and the cleaning of spray booths and exhaust ducts is generally performed with non-sparking scrapers.

All finishing rooms and spray booths should be equipped with automatic sprinkler protection and the sprinkler system should always be maintained in operation.

The alternate use of lacquers and other types of finishing materials, or of bleaching compounds such as hydrogen peroxide, should be avoided. However, if it is intended to alternately use such materials, the spray booth and exhaust duct should be completely cleaned after each operation in order to avoid one of the most prolific sources of spontaneous ignition.

The foregoing observations are generally recognized, and yet, like The Gospels, it is desirable to re-examine and re-emphasize such principles.

Readers Requested to Comment

Recognizing that the application of finishing materials by any of the new or old methods discussed in this article may create new problems relating to plant safety, the NFPA Committee on Finishing Processes wishes to invite all persons who become familiar with any of them to forward their recommendations to the Committee for consideration and evaluation.* Among the subjects currently being considered by the Committee are:

1. The proper type of construction for circulating systems employing high pressures and the safeguards to be installed to prevent the creation of fire hazards in the event of failure, such as excess flow valves, or electric messenger alarm systems.

2. Safeguards to be employed in the use of pressure pumps creating pressures for finishing materials up to 600 pounds-per-square-inch.

3. Heater construction details where heaters are under pressure and are required to heat material up to 200° F.

4. Hose having strength sufficient to withstand the pressures employed.

5. The location of such installations in relation to other operations which may be affected by the failure of any of the component parts of such high pressure system.

6. Whether infra-red drying apparatus should be permitted inside spray booth and if so what safeguards should be required.

7. The spontaneous heating characteristics, if any, of various catalysts used to speed drying.

*All suggestions should be addressed to Mr. J. W. Morris, Chairman, NFPA Committee on Finishing Processes, c/o South-Eastern Underwriters' Association, 317 Trust Company of Georgia Building, Atlanta, Georgia.

Fires and Fire Losses Classified, 1952

There were approximately 2,014,600 fires of all types in the United States in 1952 causing a loss of $942,650,000, according to estimates compiled by the National Fire Protection Association. The year 1952 was the fourth successive year in which the United States experienced an increase in both the number of fires and the fire loss.

Building fires in the United States in 1952 totalled 703,000 and caused $793,500,000 damage. An additional 1,311,600 fires not involving buildings—aircraft, motor vehicles, forest, ships, rubbish, grass fires, etc.—accounted for an estimated $149,150,000. Building fire estimates for 1951 reported in the October 1952 Quarterly, showed 625,000 fires with a loss of $739,550,000. It is interesting to note that the number of building fires for 1952 has increased 12.5 per cent over 1951 figures, while the loss of 1952 is 7.3 per cent more than the previous year. Preliminary estimates by the National Board of Fire Underwriters for the first 8 months of 1953 indicate an increase of approximately 17.9 per cent over the same period of 1952. Part of this increase reflects the loss at the General Motors Corp. plant, Livonia, Mich., on August 12.

The data from which Tables I to IV were compiled were obtained from seventeen state fire marshals' reports for the year 1952 or the closest fiscal year thereto. Reports of these particular states were chosen because they contained the most complete classification of cause and occupancy data. While the methods of reporting and tabulating fire loss figures differ from state to state, the volume of statistics from these seventeen typical states, representing all sections of the country, and including both primarily agricultural and industrial states, is sufficiently large to indicate the relative distribution of fires and fire losses. Table I shows the number of fires by occupancy in 15 states and Table II the loss by occupancy in 14 states. Tables III and IV list the number of fires and loss by cause in 16 and 12 states respectively. Table V summarizes statistics of all states that have furnished data to the NFPA.

Tables VI and VII, showing the nationwide distribution of fires and losses by occupancy and cause, are based primarily on typical state experience enumerated in Tables I to IV. Several changes have been made this year in Tables VI and VII. In Table VI the item "Packing Plants" has been changed to "Food Processing" and now includes all food processing occupancies. "Offices and multiple mercantiles" has been changed to "Offices, banks." Fires in multiple mercantiles are now reported in "Miscellaneous mercantiles." Table VII this year includes the new item "Flammable liquid appliances, including lamps, blow torches, salamanders, etc." This change consolidates flammable liquid appliance fires formerly reported in several places in the table. "Defective or overheated heating and cooking equipment" has been subdivided into oil-fired, gas-fired, and other and unknown types of equipment. All flammable liquid fires and explosions except those involving flammable liquid appliances, have been combined under one item.

Among the notable changes in 1952 experience (as compared with 1951) were an 18 per cent increase in the num-

(Continued on page 198)

TABLE I. Number of Fires by Occupancies in Fifteen States — 1952

Occupancies	Conn.[1]	Ill.[1]	Iowa	Kans.	Ky.[2]	La.	Minn.	Mont.	Nebr.	N.H.	Ore.	S.Dak.[3]	Vt.[1,2,4]	W.Va.[3]	Wisc.	Totals
I. PUBLIC BUILDINGS																
Government buildings	6	1	7	2	10	...	...	...	2	...	32	2	...	...	17	76
Hospitals, institutions	...	36	10	6	12	36	14	2	3	...	...	1	4	4	35	153
Schools and colleges	12	71	20	22	42	48	20	8	13	...	35	13	11	10	130	455
Churches	12	85	12	14	32	31	23	5	9	6	28	3	8	8	78	354
Theatres, including motion pictures	...	57	9	3	8	21	6	2	3	...	15	3	1	2	19	149
Amusement, halls	9	85	24	13	33	...	13	9	32	7	...	8	3	...	92	328
II. RESIDENTIAL																
Hotels	12	735*a*	48	31*c*	33*a*	465*a,e*	115	50	11	36*b*	520*b*	23*g*	9	16	153	2,257
Boarding and rooming houses	31	...	19	19	...	...	192*j*	36	11	...	...	...	...	...	68	376
Apartments	86	945*b*	204	90	53*b*	...	...	28	108*b*	68	...	29	26	24	322	1,983
Dwellings	936	7,670	1,623	1,554	3,846	3,717	1,190	439	618	1,055	10,541	377	713	534	23,760	58,573
III. MERCANTILE																
Offices, banks	19	206	47	19	37	422	38	1	16	84	543	8	2	16	90	1,548
Restaurants, taverns	49	657	63	52	93	...	99	19	29	26	166	...	6	21	734	2,014
Miscellaneous mercantiles	125	1,305	292	243	449	...	256	68	79	...	...	1	71	65	1,162	4,116
Warehouses	25	131	65	81	15	108	81	36	25	...	27	96*i*	2	4	161	857
IV. MANUFACTURING																
Metal workers	7	77	38	14	6	16	27	3	3	4	43	2	2	4	86	332
Woodworkers	5	44	17	5	4	36	2	2	...	8	194	...	13	...	12	342
Grain mills, elevators	...	54	29	13	9	1	27	1	31	...	11	15	1	...	90	282
Food Processing	...	4	15	16	2	34	...	3	2	...	39	...	...	...	25	140
Bakeries	10	79	5	2	5	...	2	2	3	...	6	...	...	2	19	135
Textile workers	1	...	1	3	...	131	...	...	...	...	2	...	1	1	8	148
Printing	1	...	10	5	1	...	...	...	3	...	12	2	...	4	24	62
Laundries	5	63	5	20	4	...	5	4	...	5	18	3	...	1	30	163
Cleaners, tailors	6	79	7	...	20	...	14	5	13*d*	...	...	4	1	3	50	202
Miscellaneous manufacturing	76	559	21	7	50	31	135	...	28	37	63	6	17	25	295	1,350
V. MISCELLANEOUS																
Barns	112	332	203	296*e*	416	170	115	26	299	115	272	137	186	31	1,280	3,950
Outbuildings	...	1,106	310	11	169	...	98	13	...	31	...	12	3	34	331	2,118
Lumber and coal yards	3	25	7	...	58	15	10	3	16	...	...	7	...	5	27	176
Piers, including shipyards	...	137	...	...	3	...	...	...	...	...	...	...	...	...	...	200
Railroad property, inc. rolling stock	...	...	41	20	4	26*h*	19	2	11	...	...	12	...	5	182	322
Bulk oil storage, refineries	...	12	...	7	5	62	1	19	11	...	42	1	...	2	...	162
Garages	111	1,255	63	21	73*f*	17	59*f*	36	211	37	63	72*f*	21	32	440	2,511
Filling stations	17	127	24	42	...	...	...	13	...	10	...	...	2	6	62	303
Power plants, pump houses	...	14	10	9	5	...	9	...	...	...	27	3	2	3	65	147
Creameries and dairies	...	...	10	6	8	...	4	2	11	...	3	5	1	...	58	108
Miscellaneous structures	195	610	313	15	4	189	442	10	4	115	27	23	40	28	510	2,525
VI. OTHER THAN BUILDING FIRES																
Aircraft	...	3	1	...	1	...	3	...	...	...	...	...	...	...	...	8
Motor vehicles	171	6,384	594	456	384	550	110	8	210	...	693	134	...	32	1,787	11,513
Forest fires	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Rubbish, grass, brush	...	...	85	...	1	...	8	...	310	...	...	137	...	...	...	541
Miscellaneous	5	1,760	232	27	14	...	52	3	195	...	...	48	...	18	3,792	6,146
Totals	2,047	24,768	4,484	3,144	5,909	6,086	3,189	858	2,320	1,644	13,422	1,187	1,146	940	35,984	107,128

[1] Fiscal year ended June 30, 1952.
[2] No losses less than $50.
[3] Fiscal year ended June 30, 1953.
[4] Insured loss only.

a. Includes boarding houses.
b. Includes rooming houses.
c. Includes clubs.
d. Includes laundries.
e. Includes livestock, hay, growing crops, etc.
f. Includes filling stations.
g. Includes restaurants.
h. Includes power plants.
i. Includes warehouses.
j. Includes apartments.

Totals	2,047	24,768	4,484	3,144	5,909	6,086	3,189	858	2,320	1,644	13,422	1,187	1,146	940	35,984	107,128

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e. Includes livestock, hay, growing crops, etc.
f. Includes filling stations.
g. Includes restaurants.
h. Includes power plants.
i. Includes warehouses.
j. Includes apartments.

TABLE II. Fire Losses by Occupancies in Fourteen States — 1952

Occupancies	Conn.[1]	Illinois[2]	Iowa	Kansas	Kentucky[4]	Louisiana	Minn.	Nebraska	N. H.[5]	Oregon	S. Dak.[3]	Vt.[1,5,4]	W. Va.[3]	Wisc.	Totals
I. Public Buildings															
Government buildings	$32.604	$6	$40.450	$200	$10.484	.....	.....	$425	.....	$219.024	$7.900	.....	.....	$27.092	$338.185
Hospitals, institutions	.....	47.151	7.096	1.371	7.478	$34.920	$1.370	989	.....	.....	373	$2.313	$70.610	6.060	179.731
Schools and colleges	12.267	359.112	57.960	304.979	282.522	578.606	49.526	11.907	.....	118.881	122.477	13.716	667.673	134.562	2.734.188
Churches	82.208	525.403	288.397	82.000	149.321	182.432	188.881	36.080	$88.000	40.965	3.500	7.259	96.539	84.382	1.855.367
Theatres, including motion pictures	.....	229.175	82.560	95.125	36.241	255.960	220.561	3.200	.....	2.195	12.550	435	133.988	29.482	1.101.472
Amusement, halls	52.740	197.081	172.727	149.793	287.874	.....	53.352	123.878	28.000	.....	31.182	6.671	.....	218.140	1.321.438
II. Residential															
Hotels	4.093	1.278.323a	82.214	56.496c	80.710a	562.213a,c	72.694	16.012	118.400b	402.321b	47.309g	22.238	220.622	77.715	3.047.360
Boarding and rooming houses	47.139	.....	33.855	4.779	.....	.....	472.239f	13.575	.....	.....	.....	.....	.....	16.419	588.005
Apartments	299.526	1.268.684b	312.378	53.670	61.470b	.....	.....	133.452b	15.700	.....	15.724	35.242	30.909	99.560	2.235.115
Dwellings	1.651.167	9.769.898	2.228.559	1.125.137	5.460.004	2.936.076	1.752.089	1.028.679	339.760	4.038.022	465.790	607.372	1.710.527	4.765.980	37.879.060
III. Mercantile															
Offices, banks	71.670	604.463	185.943	10.098	110.928	1.117.109	147.759	208.367	30.650	1.219.466	12.548	12.703	274.605	122.578	4.126.887
Restaurants, taverns	288.490	1.322.952	92.648	55.933	315.374	.....	347.684	173.047	35.000	230.614	.....	31.346	184.673	534.905	3.612.666
Miscellaneous mercantiles	398.898	3.642.869	2.459.805	719.257	1.514.656	.....	1.299.484	550.061	.....	.....	2.498	89.980	1.108.409	1.918.891	13.701.508
Warehouses	538.407	586.369	733.296	784.879	1.115.492	510.080	503.232	311.484	.....	54.348	589.022i	2.983	3.852.174	792.517	10.374.283
IV. Manufacturing															
Metal workers	25.534	77.602	1.081.079	64.987	13.286	73.747	88.673	12.175	27.000	308.973	12.000	66.221	154.718	227.171	2.233.166
Woodworkers	4.224	90.942	49.505	13.784	16.083	283.630	1.100	.....	84.900	2.193.949	.....	30.337	.....	33.816	2.802.270
Grain mills, elevators	.....	1.738.218	366.106	397.395	35.324	2.374	238.018	790.313	.....	83.561	466.472	2.069	.....	225.024	4.344.874
Food Processing	.....	11.850	187.083	57.986	1.007	225.815	.....	4.200	.....	406.371	.....	.....	.....	33.823	928.135
Bakeries	61.457	106.492	408.286	2.653	128.024	.....	15.150	1.120	.....	58.254	.....	.....	779	4.819	787.034
Textile workers	50	.....	294	12.381	.....	202.652	.....	.....	.....	71	.....	635	1.000	1.749	218.832
Printing	2.000	.....	31.132	2.710	718	.....	.....	19.063	.....	3.049	7.200	.....	55.329	10.857	132.058
Laundries	14.025	188.086	30.402	19.750	39.521	.....	3.500	.....	1.000	28.682	4.297	.....	200	7.087	336.550
Cleaners, tailors	39.134	91.956	2.383	.....	14.720	.....	20.071	18.513d	.....	.....	32.979	70	4.260	60.381	284.467
Miscellaneous manufacturing	903.977	2.875.340	259.751	22.380	1.866.308	667.696	884.349	487.801	600	391.305	106.606	210.509	1.889.901	1.090.380	11.656.903
V. Miscellaneous															
Barns	535.343	1.485.806	930.413	813.068e	814.344	168.242	524.343	776.805	220.290	496.059	257.222	502.862	314.125	2.427.683	10.266.625
Outbuildings	.....	1.376.567	303.558	69.567	139.410	.....	145.897	.....	30.800	.....	3.166	19.353	44.296	72.960	2.205.574
Lumber and coal yards	3.480	134.600	80.104	.....	546.122	111.058	77.775	37.960	.....	.....	126.268	.....	46.050	77.236	1.240.653
Piers, including shipyards	.....	60.800	.....	.....	3.765	.....	.....	.....	.....	.....	.....	.....	.....	.....	64.565
Railroad property, inc. rolling stock	.....	.....	41.576	38.423	8.056	30.769h	30.825	16.690	.....	.....	16.460	.....	40.050	30.339	253.188
Bulk oil storage, refineries	.....	141.405	.....	25.181	6.880	527.644	550	80.150	.....	62.950	3.600	.....	112.879	.....	959.239
Garages	232.330	2.386.463	419.160	190.863	320.669f	27.893	462.095f	190.650	56.850	351.950	131.797f	139.300	282.126	192.343	5.384.489
Filling stations	38.577	282.108	174.922	46.297	.....	.....	.....	.....	4.980	.....	.....	5.249	12.301	52.910	617.344
Power plants, pump houses	.....	30.392	35.618	3.282	19.381	.....	19.270	.....	.....	263.362	18.467	6.234	2.550	105.846	504.402
Creameries and dairies	.....	.....	4.596	8.023	11.366	.....	3.428	152.152	.....	407	29.313	34.701	.....	132.831	376.819
Miscellaneous structures	639.432	1.606.096	235.279	19.016	99.834	471.519	637.224	12.221	413.745	298.168	99.500	85.145	278.335	232.876	5.130.390
VI. Other Than Building Fires															
Aircraft	.....	3.000	1.300	.....	39.471	.....	9.200	.....	.....	.....	.....	.....	.....	.....	52.971
Motor vehicles	68.925	1.292.031	118.876	95.941	243.377	145.214	77.182	252.330	.....	136.449	34.868	.....	44.534	291.517	2.801.244
Forest fires	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rubbish, grass, brush	.....	.....	17.375	.....	1.642	.....	49.860	224.890	.....	.....	68.267	.....	.....	.....	362.034
Miscellaneous	2.068	148.573	78.214	11.471	4.572	.....	81.447	330.067	.....	.....	32.436	.....	993.168	785.190	2.467.146
Totals	$6.049.765	$33.961.813	$11.534.900	$5.356.897	$13.812.434	$9.115.649	$8.478.828	$6.018.256	$1.495.675	$11.409.396	$2.761.791	$1.934.943	$12.656.270	$14.921.921	$139.508.538

[1] Fiscal year ended June 30, 1952.
[2] No losses less than $50.
[3] Fiscal year ended June 30, 1953.
[4] Insured loss only.
[5] Uninsured loss only.
a. Includes boarding houses.
b. Includes rooming houses.
c. Includes clubs.
d. Includes laundries.
e. Includes livestock, hay, growing crops, etc.
f. Includes filling stations.
g. Includes restaurants.
h. Includes power plants.
i. Includes warehouses.
j. Includes apartments.

TABLE III. Number of Fires by Causes in Sixteen States — 1952

Causes	Conn.[1]	Ill.[1]	Iowa	Kans.	Ky.[4]	La.	Mich.	Mont.	Nebr.	N. H.	Ore.	R. I.	S. Dak.[3]	Vt.[1,3,4]	W. Va.[3]	Wisc.	Totals
Chimneys, flues — defective or overheated	74	754	119	72	363	77	2,143	56	77	173	586	45	49	...	64	234	4,886
Sparks on roof	...	254	...	15	37	17	916	...	...	...	167	...	...	4	13	...	1,423
Defective or overheated heating and cooking equipment —	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Oil-fired equipment	198	...	107	...	...	...	2,724	...	...	66	...	113a	49	112	...	1,458	4,827
Gas-fired equipment	...	...	21	..	...	...	...	...	...	...	...	...	6	...	...	186	213
Other and unknown	62	1,334	277	216	404	461	2,618	81	218	199	1,847	48	99	93	66	1,601	9,624
Rubbish, ignition unknown	...	950	...	253	216	120	4,142	...	217	14	23	38	118	5	23	197	6,316
Combustibles near heaters	5	1405	80	1	5	1	...	6	18	...	...	...	..	5	37	361	659
Open lights, flames, sparks	118	3,147	474	62	56	59	412	14	200	4	215	39	79	34	...	1,055	5,968
Hot ashes, coals	7	162	27	28	40	81	285	3	13	9	1,001	7	8	11	3	139	1,824
Smoking and matches	314	4,560	529	377	741	941	4,863	169	221	354	3,690	75	129	150	74	6,659	23,846
Children and matches	91	...	134	...	...	...	1,576	28	72	38	...	40	39	136	22	484	2,660
Electrical, fixed services, fires due to misuse, or faulty wiring and equipment	139	2,530	296	319	623	670	1,956	63	212	120	1,071	62	132	91	105	2,001	10,390
Electrical, power consuming appliances	98	277	250	22	66	97	2,112	32	79	102	558c	...	39	47	27	1,798	5,604
Flammable liquids, misuse of including vapor explosions, grease, tar, etc	60	1,378	154	167	205	340	439	60	155	70	1,665	31	24	54	36	1,539	6,377
Flammable liquid appliances, including lamps, blow torches, salamanders, etc.	12	...	63	...	...	...	...	3	3	6	...	2	10	..	24	103	226
Torches, welding and cutting	...	...	31	...	...	...	...	6	38	16	...	...	10	3	6	59	169
Gas and appliances, including gas explosions	...	186	17	38	27	100	389	25	29	13	...	...	19	6	26	68	943
Spontaneous ignition	47	370	136	17	45	27	2,767	7	93	40	68	34	37	12	12	259	3,971
Lightning	43	304	116	51	637	241	420	25	127	163	30	9	37	73	19	13,910	16,205
Thawing pipes	7	...	5	...	...	...	66	...	...	2	...	...	...	...	2	10	92
Sparks from machinery, friction	...	98	31	4	21	98	...	...	12	4	114	...	...	13	1	36	432
Incendiary, suspicious	35	112	18	9	22	34	686	2	11	25	39	36	5	3	27	109	1,173
Miscellaneous	447	4,911	709	207	110	99	29,316	14	59	74	4	207	130	9	19	1,864	38,179
Unknown	259	2,237	571	1,038	1,839	1,946	4,679	168	337	121	1,983	285	110	241	269	1,036	17,119
Explosions, miscellaneous and unclassified	13	204	9	71	191	119	...	24	24	4	114	...	12	6	2	559	1,352
Exposure	18	860	310	177	261	558	1,720	72	105	27	247	29	46	38	63	259	4,790
Totals	2,047	24,768	4,484	3,144	5,909	6,086	64,229	858	2,320	1,644	13,422	1,100	1,187	1,146	940	35,984	169,268

[1] Fiscal year ended June 30, 1952.
[2] No losses less than $50.
[3] Fiscal year ended June 30, 1953.
[4] Insured loss only.

a. Includes gas.
b. Steam and hot water pipes.
c. Includes hot metals.

[1] Fiscal year ended June 30, 1952.
[2] No losses less than $50.
[3] Fiscal year ended June 30, 1953.
[4] Insured loss only.
a. Includes gas.
b. Steam and hot water pipes.
c. Includes hot metals.

TABLE IV. Fire Losses by Causes in Twelve States — 1952

Causes	Conn.[1]	Illinois[1]	Iowa	Kansas	Kentucky[4]	Louisiana	Nebraska	Oregon	S. Dakota[2]	Vermont[1,3,4]	W. Virginia[2]	Wisconsin	Totals
Chimneys, flues — defective or overheated	$159,979	$700,955	$178,157	$75,919	$584,546	$60,786	$92,738	$344,288	$69,399	.....	$290,361	$172,539	$2,721,667
Sparks on roof	.....	248,365	.....	14,075	41,331	20,434	.....	103,642	.....	$1,304	56,809	.....	485,960
Defective or overheated heating and cooking equipment:													
Oil-fired equipment	332,296	.....	305,318	.....	.....	.....	.....	.....	66,875	127,319	.....	687,863	1,519,671
Gas-fired equipment	.....	.....	26,769	.....	.....	.....	.....	.....	3,261	.....	.....	184,480	214,510
Other and unknown	140,536	2,140,721	446,152	303,214	738,795	611,663	450,501	699,009	223,401	97,084	351,136	876,903	7,079,115
Rubbish, ignition unknown	.....	1,130,050	.....	138,771	257,010	69,660	148,249	4,594	56,202	8,310	67,834	60,641	1,941,321
Combustibles near heaters	922	188,175a	128,332	600	16,375	122	17,170	.....	.....	3,740	69,098	32,985	457,519
Open lights, flames, sparks	100,382	2,919,799	410,440	225,559	64,378	30,087	209,247	53,328	39,803	14,736	.....	520,522	4,588,281
Hot ashes, coals	2,671	207,360	19,934	24,562	55,113	50,325	18,469	269,781	1,418	12,098	2,175	55,972	719,878
Smoking and matches	652,650	4,998,090	402,418	104,353	1,003,209	285,317	288,063	463,306	120,382	37,943	348,535	1,024,768	9,729,034
Children and matches	106,908	.....	56,816	.....	.....	.....	67,322	.....	20,749	91,695	27,509	183,285	554,284
Electrical, fixed services, fires due to misuse, or faulty wiring and equipment	300,016	2,710,277	1,279,408	560,753	2,276,490	449,488	542,626	1,045,666	331,430	179,659	1,037,102	2,324,759	13,037,674
Electrical, power consuming appliances	273,932	455,810	241,252	10,704	39,882	32,312	88,393	133,551b	185,474	30,937	1,371,504	691,047	3,554,798
Flammable liquids, misuse of including vapor explosions, grease, tar, etc.	80,963	2,028,135	331,634	231,943	149,295	457,900	247,578	411,721	4,214	27,968	268,597	382,365	4,622,313
Flammable liquid appliances, including lamps, blow torches, salamanders, etc.	61,609	.....	92,781	.....	.....	.....	3,100	.....	4,204	.....	112,600	55,775	330,069
Torches, welding and cutting	.....	.....	531,473	.....	.....	.....	199,417	.....	11,255	157,564	3,505,382	88,534	4,493,625
Gas and appliances, including gas explosions	.....	201,942	159,489	28,900	116,234	87,742	146,612	.....	26,775	3,393	200,204	142,338	1,113,629
Spontaneous ignition	286,530	615,741	427,019	28,077	181,370	107,380	174,968	92,759	227,723	54,620	111,287	888,372	3,195,846
Lightning	102,775	1,007,206	386,194	211,723	745,200	108,370	563,808	5,704	56,333	63,520	80,506	1,819,950	5,151,289
Thawing pipes	34,664	.....	4,240	.....	.....	.....	.....	.....	.....	.....	12,150	19,698	70,752
Sparks from machinery, friction	.....	211,341	113,722	13,418	6,774	321,594	22,263	303,996	.....	32,988	1,430	18,517	1,046,043
Incendiary, suspicious	545,827	241,028	41,717	5,172	1,020,784	368,280	17,325	241,310	1,785	6,892	486,435	1,072,844	4,049,399
Miscellaneous	1,290,120	1,193,256	301,000	318,183	1,743,108	60,189	147,341	282	74,592	4,634	164,840	697,258	5,994,803
Unknown	1,517,611	11,029,073	4,326,672	2,870,834	4,183,809	4,894,229	2,337,349	6,828,922	871,370	934,611	3,514,995	2,426,855	45,736,330
Explosions, miscellaneous and unclassified	57,086	778,289	136,533	69,318	329,775	528,165	19,330	102,278	36,723	13,392	982	157,317	2,229,188
Exposure	10,288	956,200	1,187,430	120,819	258,956	571,606	216,387	305,259	328,423	30,536	574,799	336,334	4,897,037
Totals	$6,049,765	$33,961,813	$11,534,900	$5,356,897	$13,812,434	$9,115,649	$6,018,256	$11,409,396	$2,761,791	$1,934,943	$12,656,270	$14,921,921	$129,534,035

[1] Fiscal year ended June 30, 1952.
[2] No losses less than $50.
[3] Fiscal year ended June 30, 1953.
[4] Insured loss only.
a. Steam and hot water pipes.
b. Includes hot metals.

ber of dwelling fires, a 20 per cent increase in the number of fires in schools and colleges, a 15 per cent increase in the number of forest fires, and a 20 per cent increase in the number of building fires caused by smoking and matches and in those caused by lightning.

Various sources have furnished figures for certain items in Table VI. Railroad losses were furnished by the Association of American Railroads, Fire Protection and Insurance Section. The 1952 railroad experience shows a 15 per cent decrease in the amount of loss, but a 25 per cent increase in the number of fires. Statistics on aircraft fires were compiled by the NFPA Committee on Aviation and Airport Fire Protection. Motor vehicle data are based on a recent survey of 559 U. S. cities (Fire Record of Cities, April 1953 Quarterly).

As will be seen in Table V, the seventeen states with a population of 41,342,123 reported a total of 173,618 fires. Experience indicates that this is somewhat under half the actual number of fires in these states. Some states, for example, do not report fires with uninsured losses, others report only fires with losses in excess of $50. To obtain a more accurate estimate of the number of fires in these seventeen states, 100 per cent is added. Making use of this figure and the population ratio, the number of building fires for the nation has been calculated.

To obtain the estimated national fire loss, the population ratio was applied to the loss of the reporting states. To account for losses not reported through the usual channels, 33 1/3 per cent was added as in the previous years. Further adjustment was necessary in a few instances because of unusually large property damage in individual fires.

Table V. Fires per 1000 Population and Fire Loss per Person for Seventeen States, 1952, as Reported by Fire Marshals

State	Population 1950 Census	No. of Fires	Fires per 1000 Pop.	Fire Loss	Fire Loss per Person
Connecticut[1]	1,995,263	2,047	1.03	$6,049,765	$3.03
Illinois[1]	8,684,513	24,768	2.85	33,961,813	3.91
Iowa	2,612,598	4,484	1.72	11,534,900	4.43
Kansas	1,894,390	3,035	1.60	5,356,897	2.83
Kentucky[2]	2,944,806	5,909	2.00	13,812,434	4.70
Louisiana	2,667,022	6,086	2.28	9,115,649	3.42
Michigan	6,308,794	64,229	10.20	35,600,412	5.65
Minnesota	2,982,483	3,189	1.07	8,478,822	2.84
Montana[3]	591,024	858	1.45	1,498,087	2.54
Nebraska	1,318,079	2,320	1.76	6,018,256	5.03
New Hampshire[3]	592,880	1,644	2.78	3,816,367	6.45
Oregon[3]	1,512,100	13,422	8.87	11,409,396	7.75
Rhode Island[4]	791,896	2,380	3.01	3,052,254	3.86
South Dakota[5]	650,029	1,187	1.83	2,761,791	4.25
Vermont[3,6]	375,833	1,146	3.06	1,934,943	5.15
West Virginia[6]	1,999,097	940	4.70	12,656,270	6.34
Wisconsin	3,421,316	35,974	10.50	14,921,921	4.36
TOTALS	41,342,123	173,618	4.20	$181,979,977	$4.40

[1] Fiscal year ended June 30, 1952.
[2] Insured losses only.
[3] Buildings and contents loss only.
[4] Fiscal year ended Sept. 30, 1952.
[5] Fiscal year ended June 30, 1953.
[6] No losses less than $50.

Table VI. Estimated Distribution of U. S. Fire Losses by Occupancies, 1952

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states, they should not be taken as exact records for each class. As explained in the text, 100 per cent has been added in estimating the number of fires, and 33⅓ per cent has been added to the losses to cover unreported losses.

	No. of Fires		Losses	
I. Public Buildings				
Government buildings	900		$2,700,000	
Hospitals, institutions	1,500		1,220,000	
Schools and colleges	4,100		20,000,000	
Churches	3,100		11,000,000	
Theatres, including motion pictures	2,000		6,100,000	
Amusement, halls	3,000	14,600	8,700,000	$49,720,000
II. Residential				
Hotels	14,900		6,000,000	
Boarding and rooming houses	9,500		8,350,000	
Apartments	44,200		16,950,000	
Dwellings	397,000	465,600	203,000,000	234,300,000
III. Mercantile				
Offices, banks	13,600		16,500,000	
Restaurants, taverns	19,700		22,350,000	
Miscellaneous mercantiles	35,000		97,300,000	
Warehouses	7,500	75,800	45,000,000	181,150,000
IV. Manufacturing				
Metal workers	2,900		13,350,000	
Woodworkers	3,400		23,000,000	
Grain mills, elevators	2,900		23,500,000	
Food Processing	1,500		7,450,000	
Bakeries	1,400		3,000,000	
Textile workers	6,000		7,400,000	
Printing	1,000		2,000,000	
Laundries	1,700		2,400,000	
Cleaners, tailors	2,200		2,000,000	
Miscellaneous manufacturing	12,700	35,700	69,500,000	153,600,000
V. Miscellaneous				
Barns	24,000		45,000,000	
Outbuildings	23,900		8,500,000	
Lumber and coal yards	1,800		10,000,000	
Piers, including shipyards	1,900		14,400,000	
Railroad property, inc. rolling stock	5,700		10,200,000	
Bulk oil storage, refineries	1,900		16,500,000	
Garages	22,200		28,000,000	
Filling stations	4,100		3,500,000	
Power plants, pump houses	1,700		3,730,000	
Creameries and dairies	1,800		4,200,000	
Miscellaneous structures	22,300	111,300	30,700,000	174,730,000
Total (Building Fires)		703,000		$793,500,000
VI. Other Than Building Fires				
Aircraft	300		60,000,000	
Motor vehicles	194,000		14,550,000	
Forest fires	188,300		65,000,000	
Rubbish, grass, brush	866,000		.....	
Miscellaneous	63,000	1,311,600	9,600,000	149,150,000
Grand Total		2,014,600		$942,650,000

Table VII. Estimated Distribution of U. S. Building Fire Losses by Causes, 1952

These estimated figures are intended to show the relative order of magnitude of fire losses by causes, and while they are reasonable approximations based on the experience in typical states, they should not be taken as exact records for each class.

	No. of Fires	Losses
Chimneys, flues — defective or overheated	38,600	$29,100,000
Sparks on roof	16,200	11,500,000
Defective or overheated heating and cooking equipment —		
Oil-fired equipment	36,000	32,700,000
Gas-fired equipment	4,800	4,360,000
Other and unknown	39,200	35,700,000
Rubbish, ignition unknown	52,300	11,250,000
Combustibles near heaters	7,000	6,440,000
Open lights, flames, sparks	22,000	15,650,000
Hot ashes, coals	12,300	13,700,000
Smoking and matches	116,000	61,000,000
Children and matches	22,500	8,220,000
Electrical, fixed services, fires due to misuse, faulty wiring, equipment	55,000	75,800,000
Electrical, power consuming appliances	30,500	16,700,000
Flammable liquids, misuse of including vapor explosions, grease, tar, etc.	33,000	45,000,000
Flammable liquid appliances, inc'l. lamps, blow torches, salamanders, etc.	6,100	4,950,000
Torches, welding and cutting	5,300	6,100,000
Gas and appliances, including gas explosions	8,300	9,050,000
Spontaneous ignition	20,400	31,300,000
Lightning	39,000	33,200,000
Thawing pipes	2,000	2,870,000
Sparks from machinery, friction	4,700	5,900,000
Incendiary, suspicious	6,300	18,100,000
Miscellaneous	30,700	11,300,000
Unknown	64,500	250,310,000
Explosions, miscellaneous and unclassified	9,900	22,400,000
Exposure	20,400	30,900,000
TOTALS	703,000	$793,500,000

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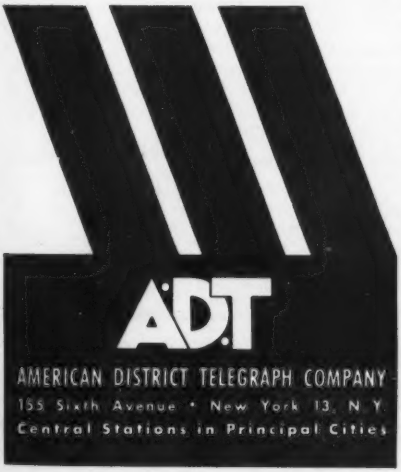
Reliability in *Automatic* fire detection depends on the degree and quality of...

SUPERVISION
INSPECTION
MAINTENANCE



Most important in considering automatic fire detection and alarm systems are the factors which assure the highest degree of reliability. Without provisions for continuous supervision, inspections, tests and complete maintenance, even the most perfectly designed equipment cannot be depended upon to function properly when an emergency arises.

Bulletin No. 261 of the National Board of Fire Underwriters says: "Experience has been that constant supervision, as rendered by companies maintaining a central supervising office, and under contract to inspect, test and maintain the system, *is the best form of service;* also, that where such central supervision is not available, then the inspections, testing and maintenance should be under contract with an experienced and dependable organization."

ADT Protection—based on more than fifty years of nationwide experience—completely meets these requirements. Whether the system operates through an ADT Central Station or is of the direct-connected type, ADT provides the specialized attention that is essential to dependable operation.

Write for complete information concerning ADT Sprinkler Supervisory and Waterflow Alarm Service or Automatic Fire Detection and Alarm Service. We shall be glad to explain how these and other ADT Automatic Protection Services can be applied to give better protection at lower cost.

DETECT-A-FIRE®

Rate Compensation Actuated THERMOSTATS insure positive Fire Detection for alarm or release systems

Fenwal DETECT-A-FIRE units are based on an entirely new principle. The outer shell is the sensing element — reacting to the temperature of the air around it. The contacts function when surrounding air reaches a danger level.

- *Hermetic Sealing* of internal electrical components.
- *Stainless Steel Construction* — for corrosion resistance and long life.
- *Temperature Setting Range*, 140 F to 725 F.
- *Long Spacing* . . . 25 feet . . . economy of installation.
- *Repeatable.* Unit re-sets itself, nothing to replace.
- *Shock and Vibration Resistant* . . . rugged construction.

SERIES 70 HORIZONTAL MODEL

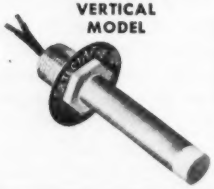
For locations where appearance is a factor. Suitable for all commercial, industrial, mercantile and public buildings, institutions and ships, in locations classified as "ordinary" under the National Electric Code.

TYPES 7020 and 7021

Flush Mounting Unit for new construction and concealed wiring. Type 7020, normally closed circuits; Type 7021, normally open circuits. Designed to fit standard 4″ junction boxes. For exposed wiring, Types 7020-1 and 7021-1 with surface adapter ring.

LISTING and APPROVALS: Ⓤ, ⟨FM⟩, USCG, and American Bureau of Shipping Acceptance.

SERIES 71 VERTICAL MODEL



For ordinary and hazardous locations i.e., Class I, Groups C and D; Class II, Groups E, F, and G. Explosion-proof in itself. For hazardous locations, mount to Crouse Hinds CPS 021 Cover or Appleton BFGS Hub Cover for explosion-proof system.

TYPES 7120 and 7121

For concealed and exposed wiring. Type 7120, normally closed circuits. Type 7121, normally open circuits.

LISTING and APPROVALS: Ⓤ, ⟨FM⟩, and American Bureau of Shipping Acceptance.

SEND FOR THESE BULLETINS.

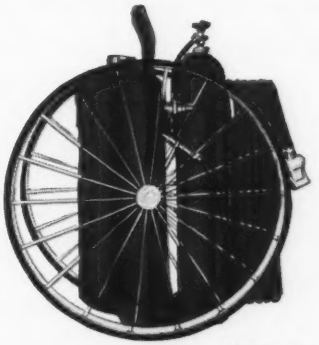
They give the latest authoritative data on fire or overheat detection. They discuss in full the rate compensation principle; give exact engineering data. Write for Bulletins MC-107A and MC-108 to Fenwal Incorporated, 1410 Pleasant Street, Ashland, Mass.

Fenwal

DETECT-A-FIRE® Thermostats

DYNAMIC, RATE COMPENSATION ACTUATED FIRE DETECTORS

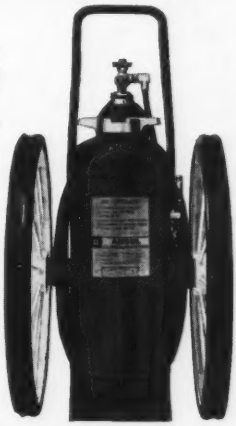
NEW ANSUL WHEELED FIRE EXTINGUISHERS *provide*



MODEL 350-B

. . . GREATER FIRE-KILLING CAPACITY . . . HIGH-SPEED OPERATION and EASIER MANEUVERABILITY . . .

Ansul "B" Model Wheeled Extinguishers are completely new. Dozens of design changes have improved their operating characteristics as well as their appearance. They provide faster, easier extinguishment of fires almost twice as large as those handled by our "A" model wheeled extinguishers. New Ansul Wheeled Extinguishers are easier to move to the fire. They can be actuated faster. They'll put out more fire faster. They're easier to recharge and maintain. And they will give even more years of trouble-free service.



MODEL 150-B
Rubber tires optional equipment

For a demonstration call your Ansul representative today. Or for additional information send for file number *W-23*.

ANSUL *Chemical Company*
FIRE EQUIPMENT DIVISION • MARINETTE, WISCONSIN

MANUFACTURERS OF FIRE EXTINGUISHING EQUIPMENT, REFRIGERATION PRODUCTS, INDUSTRIAL AND FINE CHEMICALS AND LIQUEFIED GASES

GLOBE
SAVEALL
SPRINKLER

PRODUCT OF THE CHEMICAL AGE

FOR NEW INSTALLATIONS
FOR REPLACEMENT OF EXISTING SPRINKLERS

UPRIGHT

SOMETHING NEW
•
SOMETHING DIFFERENT
•
FIREMEN EVERY 10 FEET

PENDENT

SAVEALL AUTOMATIC SPRAY SPRINKLERS
APPROVED BY ALL INSURANCE AUTHORITIES

Fifty-five years experience in manufacturing automatic sprinklers enables us to produce the Saveall Automatic Spray Sprinkler, the last word in appearance, sensitivity, durability, efficiency, quality, accuracy of performance.

Illustrated pamphlet available on request.

Manufactured and Installed by

GLOBE AUTOMATIC SPRINKLER COMPANY
Philadelphia, Pa.
Offices in Principal Cities

All over the building, fire sets its traps. In dip tanks, transformer vaults, storage spaces. Wherever it can stop a thriving business in its tracks. Be sure that every fire hazard is protected by a KIDDE Portable Extinguisher.

Kidde

Walter Kidde & Company, Inc.,
1051 Main Street, Belleville 9, N. J.
Walter Kidde & Company of Canada, Ltd., Montreal, P. Q.

RELIABLE SPRAY SPRINKLER

- Greater Coverage!
- Lower Ceiling Temperatures!
- Faster Cooling of Hot Fire Gasses!
- Better Fire Extinguishment with Less Water!
- Fewer Sprinklers Operating Adjacent to Fire Area!

Incorporating the new principle of water distribution, the Model "C" Spray Sprinkler is another example of Reliable's leadership in new product design. All Reliable Sprinkler Devices are the assurance of the ultimate in fire protection . . . and have been protecting life and property for over 30 years! Reliable Sprinkler Devices are distributed . . . installed and serviced by Reliable's chain of licensed representatives located throughout the United States, Canada and foreign countries. A Reliable representative is as near as your phone. . . . Call him for a system designed to your specific needs!

Constant Fire Protection That's Always "Reliable"!

THE RELIABLE AUTOMATIC SPRINKLER CO. INC.

"We rescued him with an AIR-PAK . . . Revived him with a Scott Inhalator. We've got the world's best equipment for these emergencies"

SCOTT Air-Paks use air (not oxygen) to protect firemen from dangerous fumes and oxygen deficiency.

• SCOTT Inhalators use oxygen or oxygen mixtures for the quick revival of victims.

"SCOTT Air-Paks are nothing short of *terrific!* Even in the most hazardous breathing conditions, we can make our rescues and reach the source of fires faster when we're safely protected and breathing cool, fresh, confidence-inspiring AIR.

. . And our life-saving Scott Inhalators have helped to revive persons suffering from over exposure to smoke and fumes. Victims of accidents or illness from oxygen deficiency are given instant relief . . . With Scott equipment along we are ready for any emergency."

FOR SAFETY—FOR SERVICE

Scott
Est. 1932

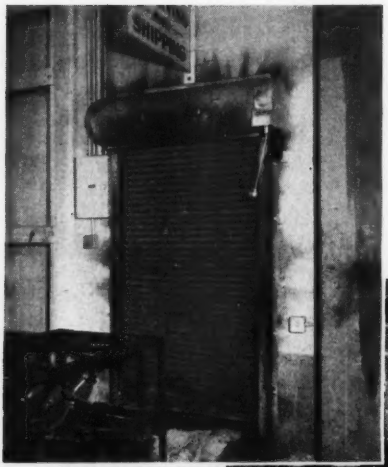
SCOTT AVIATION CORP.

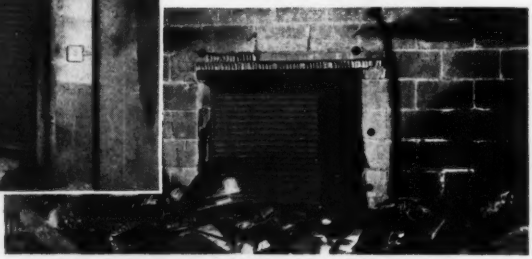
20 ERIE STREET LANCASTER, NEW YORK

In Canada: Safety Supply Company, Toronto. Branches in All Principal Cities.

AKBAR

Rolling Fire Doors Made Only By KINNEAR





These photos dramatically show protection afforded by Akbar Door in recent fire.

More Safety Features

Kinnear Akbar Fire Doors provide fast, positive fire protection at doorways and other wall openings.

Doors are automatically pushed downward when fire threatens. A strong spring provides positive action. Downward speed is controlled to insure safety for building occupants . . . and the doors can be opened easily for emergency exits. They automatically close again at once.

Another Akbar safety feature stops the door at sill level, even if the floor is burned away. A special locking device prevents the curtain from coming off the spool.

When not in use, Akbar Doors coil out of the way over the lintel. Approved and labeled by Underwriters' Laboratories, Akbar Doors can save as much as one third of their cost per year in reduced insurance rates!

Each Akbar Door is engineered for the specific opening, insuring the ultimate in closure.

Akbar Fire Doors can be equipped for daily use with motor or manual operation if desired. Where maximum fire protection is not required, non-labeled Kinnear Rolling Doors are recommended.

LARGE SIZES: Kinnear makes doors for firewall openings ranging up to many hundred square feet in area. These large doors are built with the same safety and protective features offered in the labeled doors described above.

Write for details!

SAVING WAYS in DOORWAYS

KINNEAR ROLLING DOORS

THE KINNEAR MANUFACTURING CO.

FACTORIES:

2250-70 Fields Ave., Columbus 16, Ohio

1742 Yosemite Ave., San Francisco 24, Cal.

Offices and Agents in All Principal Cities

REVOLUTIONARY

news about fire protection!

SEND FOR THIS *FREE* BOOK!

GET THE FACTS about the sensational new Rockwood WaterFOG Sprinkler Heads!

Find out how you can now apply powerful fire-fighting WaterFOG to *conventional* sprinkler systems. Take advantage of a speedy fire control that discharges millions of tiny water particles *away* from ceiling, right down into the flame area. See how gas and flames are prevented from mushrooming and needlessly opening adjacent heads. Learn how these new heads provide a cooling wall that blocks gas and flames from ceiling — how they use less water, reduce fire-and-water damage, save costly production time.

Rockwood's illustrated booklet "From Navy Fire Fighting to Better Sprinklers" brings you complete details on this amazing new Rockwood product. A result of years of research, Rockwood TU-57 and TP-57 heads are given a 30% increased fire coverage over ordinary heads by *insurance authorities*. Worth reading about. Worth specifying. Mail coupon today for your free copy.

ROCKWOOD
SPRINKLER COMPANY

Engineers Water . . .
to Cut Fire Losses

ROCKWOOD SPRINKLER COMPANY
56 Harlow Street, Worcester 5, Mass.

ROCKWOOD

Please send me your illustrated booklet on WaterFOG Sprinkler Fire Protection.

Name.....

Title.....

Company .....

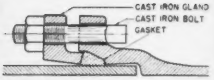
Street.....City.....Zone.....State.....

MH

MECHANICAL JOINT HYDRANT

EASY to INSTALL

Saves Labor
Saves Time



Made-up Mechanical Joint cut away to show its design.

UL&FM APPROVED & LISTED

The use of mechanical joints for pipe, valves and hydrants is growing rapidly. The reasons are easy assembly, saving in time and labor cost, and flexibility that maintains a tight, leak-proof joint under conditions such as pipe line expansion, contraction or settling.

M & H Mechanical Joint hydrant is standard compression type. The main valve opens against the pressure. Hydrant valve will remain closed in case hydrant standpipe is broken off in traffic accident. Other features include low friction loss, revolving head, dry top, easy lubrication. Hydrant shoe has two heavy lugs for use in strapping hydrant to dead-end pipe line.

M & H Hydrants are approved and listed by Underwriters' Laboratories of Chicago and Factory Mutual Laboratories of Boston. Mechanical Joint Ends are made in accordance with A.S.A. standard specification A21.11, 1952, in which a thick gasket of triangular cross section is compressed by a bolted follower ring.

For complete information, write or wire M & H VALVE AND FITTINGS COMPANY, Anniston, Alabama.

M&H PRODUCTS FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION

READY FOR ACTION WHENEVER YOU NEED IT!
NATIONAL FOAM SYSTEM
FIVE U. S. GALLONS
NATIONAL
AER-O-FOAM
LIQU
SAFE... SURE PROTECTION
because it's
FIRE TESTED
TAKE THE GUESSWORK OUT OF FLAMMABLE LIQUID FIRE-FIGHTING
National AER-O-FOAM is fire-tested . . . checked and proven on actual flammable liquid fires, for split-second, positive, fire-smothering action in your plant. Don't take chances with flammable liquid hazards. Insist on fire-tested National AER-O-FOAM, and be sure of complete, dependable protection.
Send today for your free copy of the fact-filled booklet, "What Is Foam, and How to Use It." No obligation, of course.
NATIONAL
FOAM SYSTEM INCORPORATED
WEST CHESTER, PENNA.
Headquarters for Foam Fire Protection
NATIONAL FOAM SYSTEM
CONTINUOUS FOAM PRODUCTION

FOR *Essential*
PLANT PROTECTION

PITTSBURGH • DES MOINES

ELEVATED STEEL TANKS

An ever-ready supply of water at dependable pressure contributes greatly to plant security. When a modern Pittsburgh-Des Moines Elevated Steel Tank stands guard over your plant, fire protection problems are lessened, lower insurance rates are gained, better water service is a continual benefit. *Write for our latest 20-Page Elevated Tank Brochure.*

PITTSBURGH • DES MOINES STEEL CO.
Plants at PITTSBURGH, DES MOINES and SANTA CLARA
Sales Offices at:

PITTSBURGH (25) . . . . 3468 Neville Island
NEWARK (2) . . . 250 Industrial Office Bldg.
CHICAGO (3) . 1272 First National Bank Bldg.
DES MOINES (8) . . . . . 969 Tuttle Street
DALLAS (1) . . . . 1273 Praetorian Building
SEATTLE . . . . . 576 Lane Street
SANTA CLARA, CAL. . . 675 Alviso Road

SAFER

liquid handling for Industry

THIS NEW TOKHEIM HAND PUMP contributes to safer handling of volatile liquids wherever used. Stops wasteful dripping and slippery floors. Reduces fire hazard and accidents common to other methods of liquid transfer. Approved for handling petroleum liquids—ideal for many others. Available in hose and spout models—for drums, skid tanks and underground installations. Order from your dealer, your oil company or your Tokheim representative. **Write factory for literature.**

General Products Division

TOKHEIM OIL TANK AND PUMP COMPANY

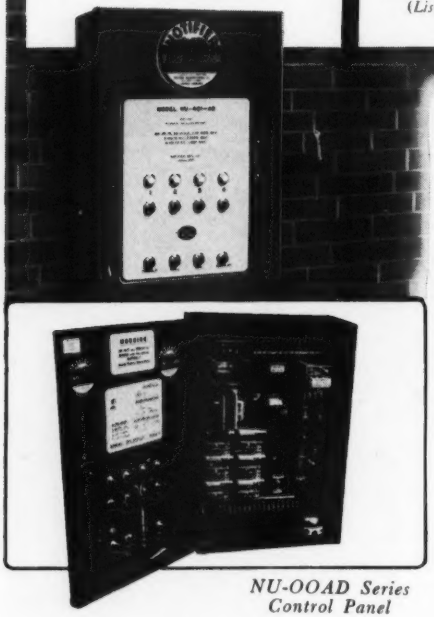
Designers and Builders of Superior Equipment Since 1901

1686 WABASH AVENUE FORT WAYNE 1, INDIANA

Canadian Distributor: H. Reeder, 205 Yonge St., Toronto

Detects and Exactly Locates a Fire in the Smoldering Stage . . .

NOTIFIER
ALARM SYSTEMS
(Listed by Underwriters' Laboratories)



NU-OOAD Series Control Panel

Sensitive Notifier thermostat detects fire in first, controllable stage; shows location on central control panel.

Simplified two conductor installation. Completely supervised against opens and AC power failures. If AC power fails, system works on DC many weeks before batteries wear out.

Custom built for nursing homes, hospitals, hotels and motels, office buildings, factories, warehouses, schools, etc.

Ideal alarm system for private homes.

Sturdily constructed; will last the lifetime of a building.

Ask for estimates by our engineering staff *and Free information.*

Act Now!
Dealer Franchises Available

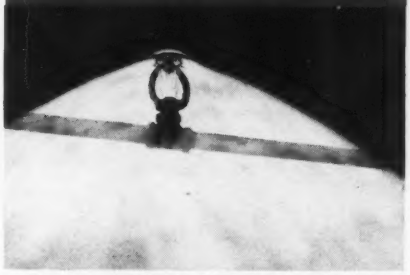
If you're in the direct selling field, or would like to start, write at once for money-making plan. Notifier has saved hundreds of lives, millions of dollars in property. Field wide open in many areas for profitable sales. Complete demonstration kits available.

Write to: Dept. Q-1

NOTIFIER MANUFACTURING CO.
239 SOUTH 11th STREET LINCOLN, NEBRASKA

The NEW BLAW-KNOX SPRAY-HEAD

stops fires where they start!



BETTER PATTERN WITH LESS WATER

You're looking at the latest development in the science of fire protection—the new BLAW-KNOX SPRAY-HEAD. In F.M. and U.L. tests this improved design showed:

- **more efficient water distribution**
- **maximum fire control with less water**
- **most effective combination of spray and mist**
- **discharge of fewer heads adjacent to fire**

So here is *far better fire protection* for the same price as old-type sprinklers! Apply it to your property without delay. No cash outlay necessary. Savings in insurance premiums will pay for the entire system in a few years. At your request our engineers will make a survey and submit an estimate without obligation. Write . . .

BLAW-KNOX

BLAW-KNOX COMPANY
BLAW-KNOX SPRINKLER DIVISION
Pittsburgh 33, Pa. CEdar 1-0700

new !

PENDENT

UPRIGHT

VIKING spray sprinklers

efficient

adaptable

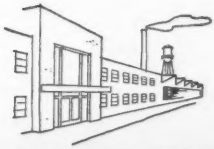
economical

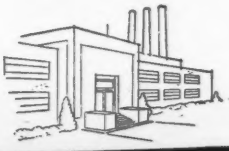
Here's the head the entire fire underwriting and protection "industry" is talking about. The Viking Spray Sprinkler incorporates an entirely new principle in sprinkler protection. Water in spray form emanates from the head at a 180° angle . . . prevents ceiling ignition . . . prevents hot gases from opening heads out of flame range. Your nearest Viking representative will give you all the details.

the VIKING corporation

HASTINGS, MICHIGAN

Offices in Principal Cities





Von Duprin

fire and panic exit devices

"THE SAFE WAY OUT!"

In buildings of all types all over the nation . . . wherever "safe exit" is a factor . . . Von Duprin devices are on duty.

Through proved performance and continuous improvement—ever since Von Duprin marketed the original exit device in 1908—these products have earned the confidence and trust of all safety-minded people.

For expert help in selecting the type of device best suited to your needs, call on your Von Duprin "Exit Specialist." For his name, write Von Duprin, or contact the contract hardware distributor in your own community.

Von Duprin PANIC DEVICES ASSURE SAFE EXIT ®

VONNEGUT HARDWARE CO. • VON DUPRIN DIVISION
INDIANAPOLIS 9, INDIANA

Yours for the asking

...this new, authoritative handbook—based on the latest research in gas appliance venting

If you specify gas appliance installations, you'll want this handbook containing complete information on the installation of gas venting systems. The findings presented are based on extensive engineering research recently completed by the Metalbestos Division, William Wallace Company, with the assistance of Stanford Research Institute.

Here are some of the subjects covered:

- *Fundamental Rules of Venting*
- *Determining Correct Vent Sizes and Capacities*
- *Choosing the Location of Vertical Vents*
- *Rules for Venting Various Types of Appliances*
- *Vent Installation Tips*

Amply illustrated throughout—and indexed for convenient reference—this handy pocket-size booklet will be an invaluable aid to anyone who specifies, sells, installs or services gas burning installations.

Send for your free copy today! No obligation.

METALBESTOS DIVISION

DEPT. T

Please send me, without cost, _____ *copies of the* **VENT INSTALLATION HANDBOOK.**

NAME TITLE

COMPANY

ADDRESS

CITY ZONE STATE

Automatic Rolling Steel FIRE DOORS *and* WINDOW SHUTTERS PREVENT SPREAD *of* FIRE!

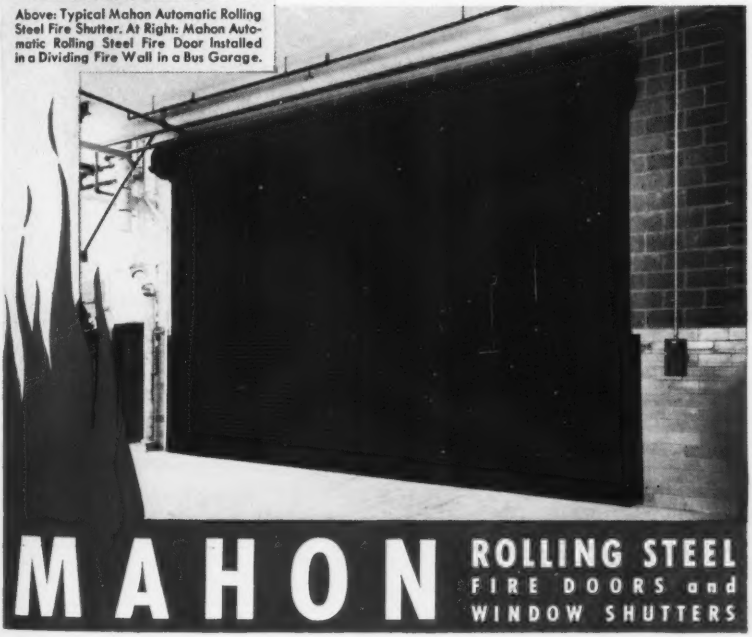
You need good automatic fire doors in fire walls, corridors, and vertical shafts . . . in some cases automatic rolling steel window shutters are necessary to protect your building and its contents from fires which may originate in nearby buildings. Many, many cases are on file which confirm that timely action of automatic rolling steel fire doors and window shutters have confined a fire to its point of origin and permitted its being extinguished with comparatively small damage. Make a survey of your building now, and don't delay action. You will find a Mahon Automatic Rolling Steel Fire Door or Window Shutter to meet each of your requirements—all bear the Underwriters' Label. These automatic fire doors may be operated manually or mechanically in every day use. If a fire should break out while they are in the open position, the automatic mechanism will close the door, cutting off drafts and preventing the spread of the fire. See Sweet's Files for complete information, or write for Catalog 654.

THE R. C. MAHON COMPANY

Detroit 34, Michigan • Chicago 4, Illinois

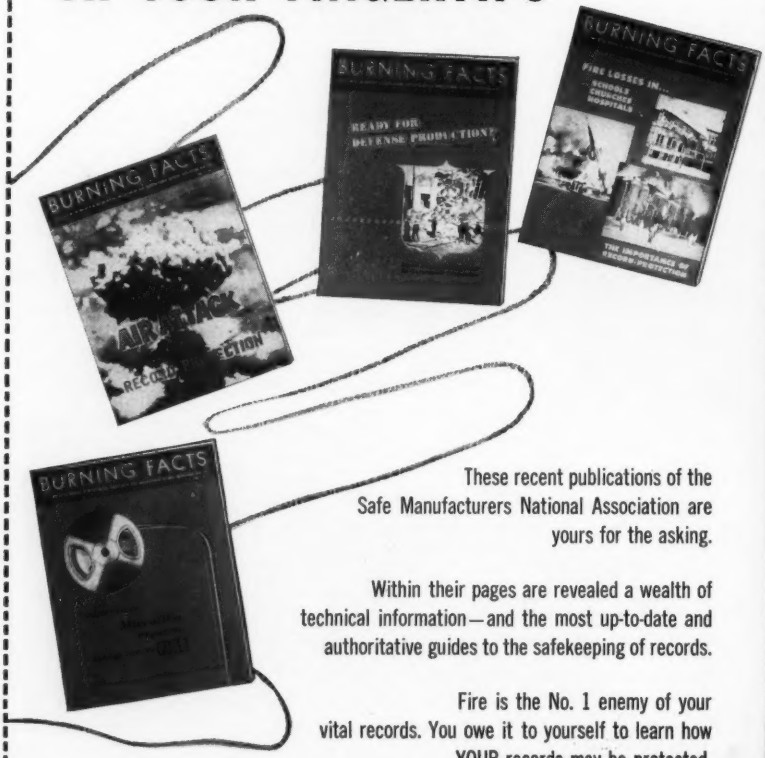
Manufacturers of Automatic Rolling Steel Fire Doors and Window Shutters. Also Many Types of Standard General Service Rolling Steel Doors and Grilles, Insulated Metal Walls, and Steel Deck for Roofs, Floors and Partitions.

Above: Typical Mahon Automatic Rolling Steel Fire Shutter. At Right: Mahon Automatic Rolling Steel Fire Door Installed in a Dividing Fire Wall in a Bus Garage.



MAHON ROLLING STEEL FIRE DOORS and WINDOW SHUTTERS

A GALLERY OF INFORMATION AT YOUR FINGERTIPS



These recent publications of the Safe Manufacturers National Association are yours for the asking.

Within their pages are revealed a wealth of technical information—and the most up-to-date and authoritative guides to the safekeeping of records.

Fire is the No. 1 enemy of your vital records. You owe it to yourself to learn how YOUR records may be protected.

Write today for one or more of the above titles. They will be forwarded promptly, and without charge, upon receipt of your request on your business letterhead.

SAFE MANUFACTURERS NATIONAL ASSOCIATION, Inc.
366 MADISON AVE., NEW YORK 17, N. Y.

The FINEST FIRE-FIGHTING EQUIPMENT IN THE WORLD IS MADE BY AMERICAN - LAFRANCE!

ALFCO

Only a few mentions are possible in this limited space, but the following will serve to indicate that Alfco makes a dependable fire-fighting unit for extinguishing every kind of fire.

Fire Extinguishers: Foamite, Soda-Acid, Anti-Freeze, all Water Types, Carbon Dioxide, Dry Chemical and Vaporizing Liquid.

Wheeled Engines: Foamite, Soda-Acid, Anti-Freeze, Carbon Dioxide and Dry Chemical

Fire Extinguishing Systems: Foamite Single Powder, Alcofoam Single Powder, Foamite Dual Powder, Foamite Two Solution, Foamite Airfoam, and Alfco Carbon Dioxide.

Fire Hose: Alfco Allweather Fire Hose, white and clean, flexible for easy racking, strong and durable, seamless tubing, smooth waterways, double jackets tailored to fit, flat-cured. Wide range of selection.

Fire-Fighting Supplies: Every need of the fire service can be promptly supplied from our complete stock of the most modern equipment.

Alfco Provides a Complete Engineering Service Against Fire

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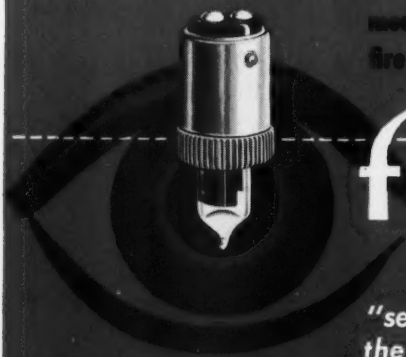

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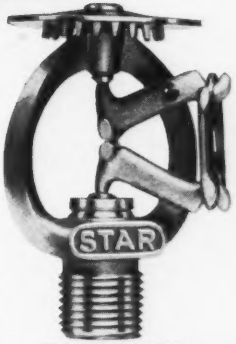

(MODEL C—UPRIGHT)

With its

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Gives You . . . . . .

SUPERIOR PROTECTION — revolutionary in method — for any type of occupancy — no matter how severe the hazard . . . . . with

LESS WATER USED — more effectively and more efficiently — for total extinguishment and cooling. . . . All water discharged goes directly on the fire — not on the ceiling. . . . Ceilings are so cooled that no sprinkler will open unnecessarily. . . . . .

STAR SPRAY SPRINKLERS — the ultimate in modern fire protection — can replace former-type sprinklers without changes in piping. . . . . Available for installation in either **UPRIGHT** or **PENDENT** position.

Approved by Factory Mutual Laboratories
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Write for name and address of STAR licensed contractor nearest your location, to:

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Use ROLAGRIP couplings for fast, low cost sprinkler installation

This is a 6″ ROLAGRIP coupling for plain end pipe on a sprinkler bulk line in a midwestern aircraft plant. ROLAGRIP couplings and plain end steel pipe were used here because the contractor had to install a permanent, low cost sprinkler system *in a hurry.*

Because the sprinkler system was coupled with ROLAGRIPS, pipe came straight from the mill in economical mill run lots . . . ready to install. It required no special machining, handling or shipping preparation. The pipe was not weakened by threading, beveling or grooving.

Installation time and labor were cut because ROLAGRIPS go on in three steps: (1) grease the special synthetic rubber gasket (to prevent pinching) and center it over the pipe ends; (2) lay twin ROLAGRIP housing halves over gasket; and (3) insert and tighten two bolts.

Chances are, ROLAGRIPS will save you time and money, too. They come in 1½″ to 12″ sizes; are approved by Factory Mutual and Underwriters' Laboratories.

See ROLAGRIPS at your supply store this week. (For grooved pipe, ask for GRUVAGRIPS and GRUVAGRIP FITTINGS — sizes ¾″ to 14″.) Or write today for prices and free illustrated folder #NCF.

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210 West Tenth Street **Kansas City 6, Missouri**

DUAL SERVICE TANK

Provides Fire Protection at Hatch Mill

The Hatch Mill Corporation has installed the 125,000-gal. Horton elevated tank 100 ft. to bottom, shown at the right, to provide gravity water pressure for general service and fire protection at its plant in Columbus, N. C.

The Hatch Mill was placed in operation on July 3rd, 1951. It contains 204,000 sq. ft. of floor space and occupies 3 acres of a 140-acre plot. It manufactures 175,000 yds. of fancy woolens per month, which are sold under the "Lorette®" trade name.

The 125,000-gal. elevated tank is piped for dual service, with one half of its capacity available for general service and the other half reserved to provide the primary water supply for the automatic sprinkler system throughout the building. Secondary supply is a ground-level storage tank.

Write our nearest office for information or quotations on elevated tanks. State capacity, height to bottom and location.

CHICAGO BRIDGE & IRON COMPANY

CLEVELAND CHICAGO BIRMINGHAM LOS ANGELES
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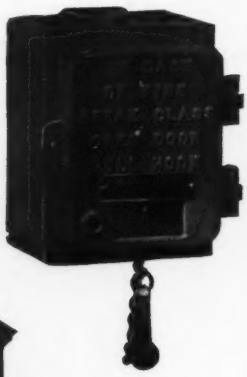
Plants at Chicago, Birmingham, Salt Lake City and Greenville, Pa.



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Bump that assures positive results

When fire strikes, seconds count . . . your fire extinguishers must be the right type and function properly from the very start . . . failure means serious losses.

The growing popularity of the highly effective powdered dry chemical fire extinguishing agent may be hampered by a drawback . . . settling or packing can occur after a lapse of time. However, with C-O-TWO Dry Chemical Type Fire Extinguishers, there is no chance of this happening.

The exclusive inverting and bumping design of C-O-TWO Dry Chemical Type Fire Extinguishers provides mechanical breakage of the dry chemical by shifting its position in the cylinder. This outstanding mechanical breakage, plus continuous inert gas pressured agitation or fluffing of the skillfully blended dry chemical, guarantee lasting, foolproof fire protection.

No other brand on the market today gives you this extra margin for positive results. Inverting and bumping is only one of many unique design advantages that make C-O-TWO Dry Chemical Type Fire Extinguishers your best buy for killing flammable liquid and electrical fires, as well as surface fires involving ordinary combustible materials.

With C-O-TWO Dry Chemical Type Fire Extinguishers the heat-shielding dry chemical is a non-conducting, non-abrasive, non-toxic, finely pulverized powder compound . . . blankets fire instantly. Sizes range all the way from 4 to 150 pounds capacity . . . all fully approved by the Underwriters' Laboratories, Inc., Factory Mutual Laboratories and Government Bureaus.

Act now for complete free information on these top quality, sure-acting fire extinguishers. Remember fire doesn't wait . . . get the facts today!

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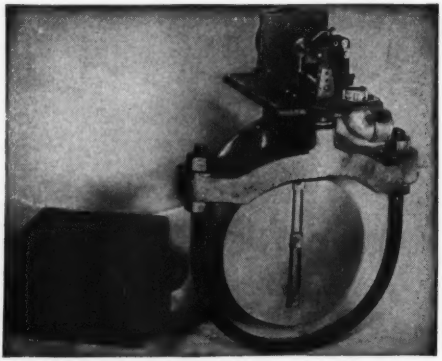

5-inch size shown above. To install simply drill 2-inch hole in pipe.

CENTRAL STATION SIGNALS, INC. Model PRS

Waterflow Alarm Device is approved by both the Factory Mutual Laboratories and Underwriters' Laboratories, Inc. In hundreds of installations it has proved to be the ideal alarm device for sprinkler systems.

SAVE VITAL MATERIALS! Install this water flow alarm device in place of bulky alarm valves. Only 10 oz. of vital material used in our water flow switch.

- **Made in all sizes from 2½" to 8"**
- **It is positive in operation**
- **Has instantly recycling pneumatic retarding device which prevents false alarms**
- **Has enclosed electrical contacts for 15 amp, 125 volts AC and ½ amp, 125 volts DC**

By installing this most economical alarm device, you will know instantly where the water is flowing. Many plants are having them installed on each floor or in each section. They save water damage.

This device can also be obtained as Model PRT, a coded waterflow transmitter from which signals are received on a punch register and single stroke gong. Practically any number can be installed on a two-wire system, thus resulting in considerable savings on wiring.

WE SOLICIT YOUR INQUIRIES

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Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

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And you can say that again...

. . . because when you help yourself to fire prevention material, you help yourself in many ways.

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Not just during Fire Prevention Week, but all year 'round, make fire prevention work a continuing activity. Motion pictures, prepared talks, posters and booklets are available from many insurance companies, from the National Board of Fire Underwriters, the National Fire Protection Association and the National Association of Insurance Agents.

So . . . help yourself. You'll get a *double* helping every time.

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WITH

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Ansul Met-L-X Dry Powder Extinguishers allow safe and effective application of a special fire extinguishing compound to burning metal fires. When applied to a metal fire, Ansul Met-L-X Dry Powder fuses and forms an air-excluding crust over the burning metal.

Ansul Met-L-X Dry Powder is free flowing and water-repellent. It may be stored, at normal temperatures, indefinitely, without deterioration.

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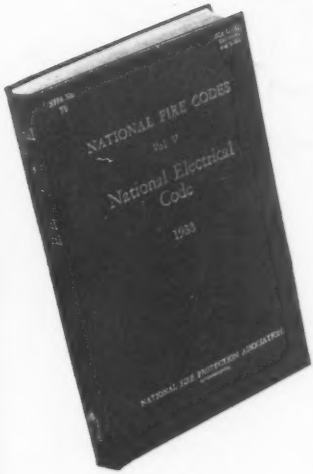

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Central Upright Spray Sprinkler Type "A-S"

Combining all the superior features of the Central conventional type of automatic sprinklers (which 33 years of unequalled service have demonstrated) with the Central specially designed spray type of distributors, we present the complete line of Central Spray Sprinklers.

Central Spray Sprinklers are more effective and more efficient than any other type of sprinkler.

Their greater area of distribution and their lesser consumption of water combine to produce earlier extinguishment of fires with less water used, smaller pipe sizes and, in most cases, a lesser number of sprinklers required for the same areas.

Therefore, you save money in first installation cost and your fire damage is lessened if a fire occurs.

In every way, you profit by using the latest developed and the most efficient Central Spray Sprinklers.

Manufactured and Installed by

CENTRAL AUTOMATIC SPRINKLER COMPANY

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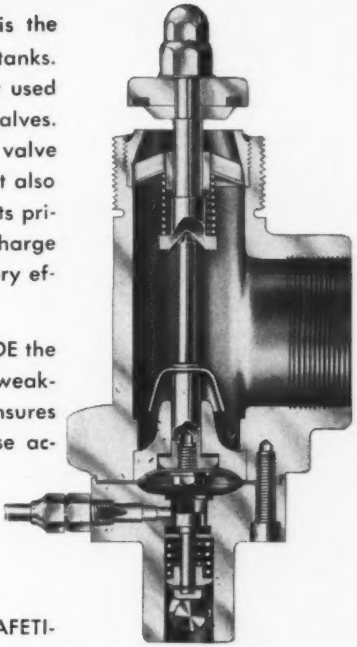
Licensees in principal cities in U. S. of America and Canada and throughout the world.

FOR SAFER LP-GAS DELIVERIES

S&J "SAFETIFLO"

THE Shand & Jurs "SAFETIFLO" is the ideal shut-off valve for LP-Gas truck tanks. It is designed to replace the currently used excess flow check and shut-off valves. "SAFETIFLO" acts as a tight shut-off valve and as a back pressure check valve. It also serves as a filler check valve though its primary function is as an automatic discharge valve providing greater LP-Gas delivery efficiency with maximum safety.



The S&J "SAFETIFLO" is mounted INSIDE the truck tank, and is provided with a weakness groove outside the tank which insures breakoff below the valve seat in case accident tears away discharge lines. "SAFETIFLO" can be opened only by willful, manual operation of its priming cam, and when primed, only pressure exerted by the discharge pump can effect delivery. "SAFETIFLO" is guarded by a fusible plug which melts at 165°F. A contiguous fire melting the fusible plug, or mishandling that causes loss of pressure in discharge lines will close "SAFETIFLO" instantly and automatically.

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Sure Fire Killer!

"Automatic" SPRAY Sprinkler

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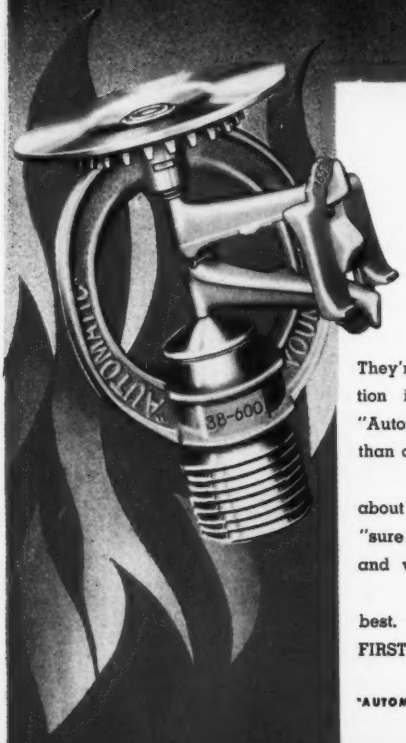

YOU should specify "Automatic" SPRAY Sprinklers for your new building now in the planning stage or an old one, soon to be renovated. For here is a completely new fire fighting device that provides protection far superior to conventional approved sprinklers. They're recognized as preferred for installation in all types of occupancies. Yet, "Automatic" SPRAY Sprinklers cost no more than old style heads.

Ask any fire insurance underwriter about "Automatic" SPRAY Sprinklers, the "sure fire killer." He knows the facts of fire and what's needed for maximum safety.

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The connecting link between the private fire alarm system or sprinkler system and City Fire Department is the Master Box.

Your fire losses are beyond the curb line. And you aren't getting 100% value from your alarm system unless your city circuits are interconnected through the Master Box to industrial plants, schools and public buildings.

Protect yourself and your citizens *all the way*. Close up the gap. Remember, you depend on industry — it's up to you to protect it.

GAMEWELL

THE GAMEWELL COMPANY, Chestnut St., Newton Upper Falls 64, Mass.

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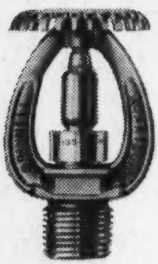
GRINNELL SPRAY SPRINKLERS



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DuraSpeed Upright

Put Out More Fire with Less Water

Grinnell Automatic Spray Sprinklers create a high, wide and even distribution of water — for maximum cooling of fire gases and quicker extinguishment of fire. These Sprinklers provide —

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